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ARMY ORDNANCE

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Army Tank Advancing Through a Smoke Barage

International Newsreel

ORDNANCE ON THE PACIFIC COAST
Col. Bruce Cornwall, Ord. Res., U. S. A.

PACIFIC COAST STEEL INDUSTRY
Dr. Welton Joseph Crook

WESTERN INDUSTRIAL DEVELOPMENT
C. A. Handschin

ORDNANCE UNIT AT STANFORD UNIVERSITY
Lieut. Col. Theodore J. Hoover, Ord. Res., U. S. A.

ORDNANCE UNIT AT UNIVERSITY OF CALIFORNIA
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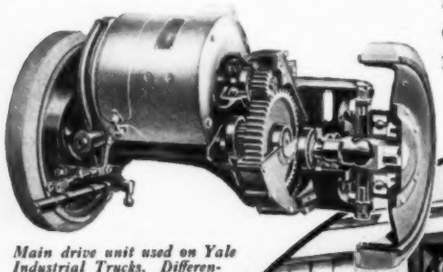

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"The increasing interest all over the nation in Industrial Preparedness is a frank declaration to the world that we not only want peace but that we intend to have it." Hanford MacNider, Assistant Secretary of War.

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THE Army Ordnance Association is a national organization of American citizens pledged to industrial preparedness for war as our nation's strongest guarantee of peace.

THE Association endeavors to keep alive an interest in and knowledge of the design, production and maintenance of munitions. Other than a few manufacturing arsenals—six in all—there is no peace-time industry for the production of ordnance. Should war unhappily come again, industrial America will be called upon to produce munitions in great quantity and of intricate and unusual design. In an emergency time will not permit careful study or long preparation for the production of munitions. The problem is one of vital concern.

BASED on experience, the Army Ordnance Association believes that the solution of this problem lies in an active organization at all times cooperating with the Government. The principal objective of the Association is an active membership of American citizens, on whom the duty of design and production of munitions will fall in war, who will have an accurate and authentic knowledge of the complex requirements of ordnance. "Peace Insurance" in this form is the foremost aim of the Army Ordnance Association.

THE Association is purely patriotic; it has no commercial interests, it has no political alliances, it has no religious affiliations. It is not operated for profit; its income is expended in furthering its aims. Its officers and directors serve without remuneration.

ARMY ORDNANCE, the journal of the Association, is published solely for the purpose of disseminating information on the progress of our munitions developments so that American industry may at all times know its responsibilities to the common defense.

The objectives of the Association as set forth in its Constitution are:

To assist in effecting industrial preparedness for war as being one of the nation's strongest guarantees of peace;

To keep available the highly specialized knowledge necessary for arming the manhood of the nation by stimulating interest in the design and production of ordnance material;

To promote mutual understanding and to effect cooperation with American Scientists, Inventors, Engineers and Manufacturers in civil life and the Regular and Reserve Officers of the Army Ordnance Department;

To provide, when required, the services of competent committees to investigate and report upon special ordnance subjects;

To assist in developing and maintaining an efficient personnel, both commissioned and enlisted, for the units required for Ordnance Field Service in the event of an emergency;

To commemorate the services rendered by the Industry of the Nation and by the Officers and Civilian Employees of the Ordnance Department in the wars in which the United States has been engaged.

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Chief, San Francisco Ordnance District

Ordnance on the Pacific Coast

Col. Bruce Cornwall, Ord. Res., U. S. A.

THE San Francisco Ordnance District was established in the early part of 1923. It includes within its boundaries the States of Washington, Idaho, Oregon, California and Nevada. The early industrial development of this area was built about the activities of the principal ports and the requirements for machinery for lumbering and mining, and later, shipbuilding. The plants having facilities for possible munitions production are located principally in the region in and about Portland and Seattle on the north, the San Francisco Bay region, and in Los Angeles. Most of the industrial developments brought about by the large increase in the consuming power of the growing population and the growth of the export trade are located in these same regions. The wide separation of these centers of activity influences adversely the operations of any organization covering the Pacific Coast area. It is reflected in the organization of this district which provides for what are practically sub-district offices in Seattle, Portland and Los Angeles.

There has been a steady growth in both number and size of the manufacturing plants in the last few years and there is every reason to believe that this growth will continue abreast of the development of the country. The essential requirements for such growth are available in raw material, power, transportation and labor.

The work of the district in the last three years has included the preliminary surveys of facilities. Over 220 plants have been visited, more than 100 of which are now allocated to the Ordnance Department. The allocations received from the Chief of Ordnance have been placed with local manufacturers and the work of recruiting and training reserve officers has been carried on.

This record is probably typical of the recent history of most of the Ordnance districts. There are two things, however, which serve to make the work in this district different from the Eastern districts. First is its widespread area making communication and especially personal contact difficult. The second is the fact that there does not exist in this district among its manufacturers the intimate personal knowledge of Ordnance manufacture that is found in the East. Most of the industrial activities of the last war, except shipbuilding, were east of the Mississippi. It has been noted that this lack of familiarity with Ordnance manufacture has a marked influence upon the progress made in the preparation of the factory war plans.

One of the most satisfactory and pleasing phases of the work has been the helpful relations established with the various manufacturers, associations and engineering societies established in this district. Naturally those organizations closest in touch with the manufacturer and the engineer have been most helpful and of these the California Manufacturers Association deserves special mention. Its records have been always at the disposal of this office. Its current publications and circulars have been employed as the medium for bringing to the attention of the manufacturer the work undertaken by the Ordnance Department in this district and it has cheerfully obtained through its channels much valuable information required for this district from time to time. It is obvious that the work of the district is greatly helped by maintaining close contact with such organizations. Their records both as to personnel and plants are complete and kept current in much greater detail than the limited facilities of the district permit for its own files.

The few years' experience in this district has been briefly summarized in the preceding paragraph. The experience gained in this time leads to certain general observations and conclusions with respect to the future of the undertaking. It is essential that satisfactory relations be established with the prospective manufacturers and their personnel. To revert to the language of the salesman, the Ordnance Department is trying to "sell" the idea, that its "customers" are to contribute some of their time, thought, and effort by cooperating in preparation for any "next war." In this effort the Department meets with what in the technical language of the sales engineer is called sales resistance. The curve of this sales resistance is quite likely to be a fairly straight line curve with a large corporation showing the least resistance and the individual the greatest resistance. This is quite a natural state of affairs. In the first place the demand for information in the way of data for factory war plans, etc., is not at all proportional to the size of the corporation. It is relatively greater upon the small organization. The large corporations have usually a comfortable provision in their budget of overhead to cover the cost of meeting such a request and presumably many other like calls made upon them from which there is no prospect of drawing immediate return. The small corporation or company or partnership, when it puts a draftsman or engineer at work on the factory war plan, or a machine tool requirement, or a layout of floor space, must charge the time involved to profit and loss, and to the owner or part owner sitting at the desk of the superintendent or manager of the plant it looks very much like money out of his own pocket without the consolation of writing it off as a contribution when he comes to make up his income tax return. When it comes to the individual and especially to the reserve officer very keen competition is met from his many other legitimate interests. Other things being equal, the young men that are most valuable are usually extremely busy. They are working under very high pressure to make themselves a place in their profession or business and are devoting most of their time and attention to the effort.

So far as manufacture is concerned it may be predicted that unless the whole enterprise is placed on a strictly business basis by paying for services rendered it will become more and more dependent upon the larger corporations. The large corporations are able to look further into the future. They are willing to make some expenditure now to protect themselves against the industrial chaos that a first-class emergency would bring about. The prospect

of an uninterrupted production program throughout a war based upon an anticipated transition from peace-time to war-time products is looked upon as a sufficiently profitable return from the small investment they are now asked to make and continue to make in industrial preparedness. Their management can be convinced that the carrying out of such a preparation will tend to stabilize general conditions in the country in the early part of any emergency, to their own general advantage and security. These reasons are not so likely to appeal to the small manufacturer and to the individual.

It is increasingly evident that the factory plan is the cornerstone of the district structure. The progress of the district must be determined by the degree of completion of its various factory plans. It is very difficult to find a common denominator to apply to the various plans in order to report a percentage progress. Each plan is bound to take upon itself the complexion and form of the plant organization and management to which it applies, and of course there are in any district very great differences among the manufacturing plants useful to the Ordnance on account of their size, products, resources, etc. Projecting the resultant curve of progress on these plants into the future it is apparent that after a period of some years the district system will have produced a plan for Ordnance manufacture in time of war that will be fairly complete in detail, and for the conditions and with the personnel connected with it will be extremely valuable for a current emergency. What must be done then to keep it alive and to make it equally valuable for an emergency ten years or twenty years hence? With the war plans completed either as a voluntary contribution or paid for by the Department, how is contact to be maintained with the manufacturers or with the managements? They are very busy people, too busy to receive casual visitors and not at all inclined to post-mortem discussion. And yet the district annex and the factory war plans, if locked up carefully in the files, will very quickly lose their value. So this brings back the old question of the manufacture of war material in time of peace which has been so often discussed in the last ten years and which seems to have become involved industrially and politically in such a way that it now seems difficult indeed to gain for it a consideration upon its own merits. Yet the permanency of the industrial preparedness plans seems to depend upon it.

Equal in importance to the factory war plan is the problem of recruiting and training qualified reserve officers of the post-war generations. The principal source of supply for the younger officers should be the Ordnance units of the Reserve Officers' Training Corps established in the engineering schools of the country, supplemented by individual recruiting through personal contact. Military training in time of peace must of necessity be a compromise between a training course that is essentially a frequently repeated drill for the individual in the duties of the position to which he is assigned, and a schedule for the training period offering a sufficient variety of interesting assignments calculated to hold the interest and to retain the services of the average group of reserve officers. In time of war or in time of peace under a compulsory system of training the highest efficiency of any organization would be obtained by confining all training to making the individual letter-perfect in his own duties. In preparing a two weeks' training schedule for a group of reserve officers a compromise must be effected between these two conflicting requirements. Such training periods are further complicated by the fact that as each group comes to active duty it includes a number of officers on their first tour of duty since their appointment or since the war. In this Ordnance District two annual training periods of two weeks each have been held with an attendance of reserve officers on active duty sufficiently large to permit some conclusions to be drawn from the results obtained. These tours of duty have included instruction at Benicia Arsenal and field service duty, including a field service problem; instruction in the various duties of the Corps Area Ordnance Officer given in the office of the Ninth Corps Area; a tour of inspection of the various Ordnance activities in the harbor defenses of San Francisco; and visits to a number of the manufacturing plants in the vicinity of San Francisco allocated to the Ordnance Department. These features have been arranged to offer a variety of interest and to give the reserve officer a more general idea of the activities of the Ordnance Department. During each training period the annual war game of the district has been held, the sessions of which have been attended by the manufacturers or their representatives to whom allocations have been made. The daily program in every case includes a period devoted to a study or drill in the organization and operation of the district and the duties to which each individual is assigned. In view of the responsibilities placed upon the district chief he must always bear in mind that the primary purpose of such training periods, when the reserve officers assigned to this office are on active duty, is to drill them as a group in their assigned duties so that the district may function in the event of an emergency with the highest possible efficiency. For purposes of this drill the District annex is the best textbook available.

Another difficulty that is encountered arises from the fact that such instruction has a very limited technical value. For the present, at least, and as long as there are officers available who received some technical training in Ordnance during the war, this defect in training is not so apparent; but having in mind the younger officers that come in from civil life or as graduates from Ordnance units it seems to be necessary to provide some advanced technical training to supplement the district organizational training, and the general information gained through familiarity with the various phases of the department's activities. For an officer who is actively interested in some technical feature of the work of the department and who has kept himself posted upon Ordnance work, a continued repetition of a tour of duty during the annual training period will not continue to be profitable. In this matter this district finds itself at a disadvantage because of its remoteness from the large manufacturing arsenals and the proving grounds of the Ordnance Department where such advanced technical courses are given. Fortunately the School of Engineering at Stanford University is offering a two weeks' course this year for Ordnance reserve officers in technical subjects. This course includes lectures in Ordnance engineering, chemistry of explosives, ballistics and metallurgy. Laboratory courses are also offered in Ordnance metallurgy, chemistry of explosives, and Ordnance engineering. These lectures will be given by members of the Engineering School faculty who are Ordnance reserve officers or who

have large practical Ordnance experience. It is expected that there will be available for this course a group of young reserve officers who are graduate engineers and well equipped to profit by such a two weeks' course.

In any discussion of the district system it is well to remember that today the generation in control of affairs is a generation that has had a complete and extensive education in war-time organization. It would not have been very difficult to reconstitute in 1920 the war-time machinery as it operated in 1918. Today it would be a very much more difficult thing to do. Twenty years from now failure in this respect may be fatal to success in war. One is too apt to measure the problems of the future—the problems that may confront the nation twenty years from now—by conditions of the present or even of the past. A proper consideration of the problems of industrial preparedness will proceed on the assumption that the next war must be organized and operated by men having only a theoretical knowledge of what is involved. An adequate plan for an emergency always assumes the worst possible conditions and the plans for industrial preparedness should not be based upon the assumption that men will be available for key positions who functioned actively in their professions or in the war-time machinery during 1917 and 1918.

The doctrines of industrial preparedness are clearly defined, and are well worth careful consideration. They are based upon the experience of the late war and a study of the probable situation confronting this country in the next war. To attain that degree of industrial preparedness that is one of the essentials of success, this work must be so conducted as regards the recruiting and training of personnel that eventually the key men in the industrial activities of the nation shall be brought to recognize these doctrines, to understand them in a broad way, and to subscribe to them as a necessary guide for peace-time operation.

Reserve Officers Assigned to the San Francisco Ordnance District

*Col. Bruce Cornwall, 58 Sutter St., San Francisco, Calif.
*Lt. Col. T. J. Hoover, Stanford University, Palo Alto, Cal.
*Lt. Col. F. L. M. Masury, 1814 Anacapa St., Santa Barbara, Calif.
*Maj. W. H. Adams, 823 Harvard Ave., Burbank, Calif.
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*Maj. A. W. Copley, 1205 Drake Ave., Burlingame, Calif.
*Maj. E. J. Ellis, 7651 Fountain Ave., Hollywood, Calif.
*Maj. A. A. Hedge, 19th and Harrison Sts., care Pelton Water Wheel Co., San Francisco, Calif.
*Maj. F. T. Letchfield, Wells Fargo Bk. & Union Tr. Co., 4 Montgomery St., San Francisco, Calif.
Maj. Samuel Powell, 524 Oregon Bldg., Portland, Oregon.
*Maj. O. F. Reynolds, 2700 West Lake St., Seattle, Wash.
Maj. A. E. Ridenour, 325 S. 13th St., Corvallis, Oregon.
*Maj. James Spiers, 1512 Hearst Ave., Berkeley, Calif.
*Capt. A. N. Armitage, 550 E. 12th St., Pittsburg, Calif.
*Capt. H. W. Christenson, Llewellyn Iron Works, 1200 N. Main St., Los Angeles, Calif.
*Capt. J. W. Criglar, 1165 Bay St., San Francisco, Calif.
Capt. J. A. Denn, 231 N. Main St., Roseburg, Oregon.
*Capt. W. A. Doble, Jr., 97 Tunnell Road, Berkeley, Calif.
*Capt. A. B. Domonoske, Box 2696 Stanford University, Palo Alto, Calif.
*Capt. W. R. Faweett, 456 S. Oxford Ave., Los Angeles, Calif.
*Capt. Dozier Finley, 2725 Ashby Ave., Berkeley, Calif.
*Capt. H. O. Holt, 237 Gratan St., San Francisco, Calif.
*Capt. J. F. Lyon, 1012 N. Los Robles, Pasadena, Calif.
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*Capt W. M. Moody, care Pelton Water Wheel Co., 2929 19th St., San Francisco, Calif.
*Capt. Eric Nilan, 1704 Turk St., San Francisco, Calif.
Capt. R. W. Smith, 804 Hellman Bank Building, Los Angeles, Calif.
*Capt. F. G. Tickell, 652 Forest Ave., Palo Alto, Calif.
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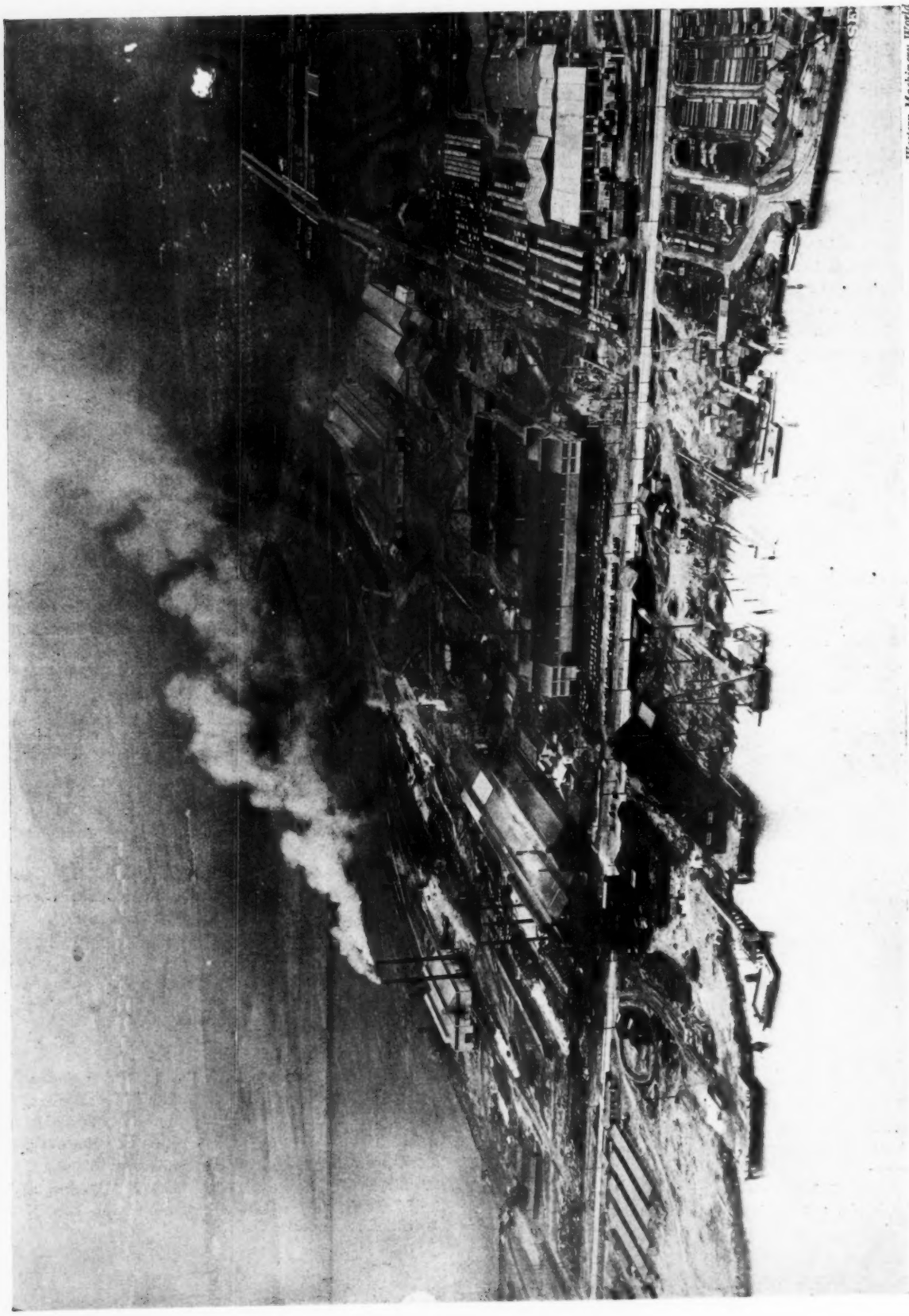
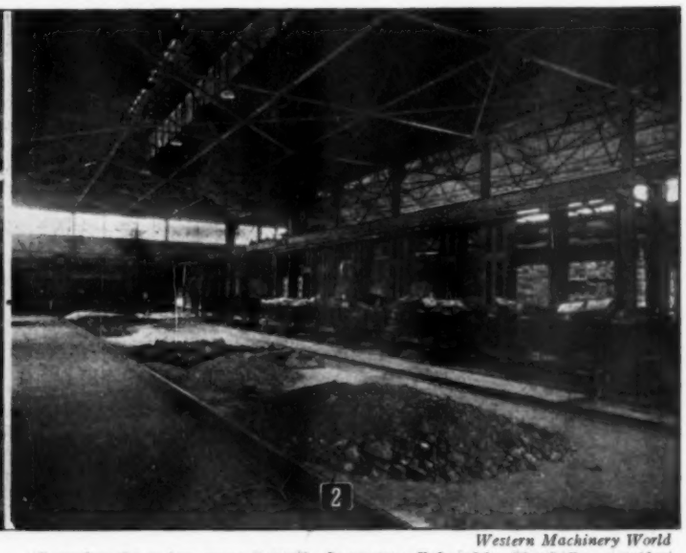
Editor's Note: The above list was compiled as of January 15, 1927.



Western Machinery World

The Pittsburg, California, plant of the Columbia Steel Corporation.

Tapping a heat from one of the five open hearth furnaces for pouring rolling mill ingots, Columbia Steel Corporation.



Western Machinery World

Charging floor for open hearth furnaces, Columbia Steel Corporation. One of the charging machines in the background.

Pacific Coast Steel Industry

Dr. Welton Joseph Crook

UNDER the present plans of the Ordnance Department for peace-time mobilization of industrial facilities against the time of national emergency, allocations for the production of munitions and equipment have been made so that the various centers of population and potential sources of man power may be encouraged, as far as possible, to produce the material needed to arm and supply the troops mustered in these areas. By these plans, not only will the strain of war-time demands on transportation be greatly lessened, but, still more important, will the burden on skilled labor be distributed to better geographic advantage.

Under the pre-war system the centers of munition production were very few, resulting in a heavy demand with very great congestion of effort. At the present time certain allocations have been made to the Pacific Coast, and the nature of the material required is such that the ability of the Coast to produce steel of proper quality and quantity is essential. Therefore, it may be of interest to members of the Army Ordnance Association, officers of the Regular Establishment and to the Reserve Corps of the Ordnance Department to know something of the present status of the steel industry on the Pacific Coast.

Dr. Welton Joseph Crook.

History

Although pig iron was the first *ferrous* metallurgical product on this coast, there is no production of it at the present time. There are a number of reasons for this, one of which is the fact that, although some excellent bodies of iron ore exist, they are not located near any deposits of coal which are suitable for the manufacture of metallurgical coke.

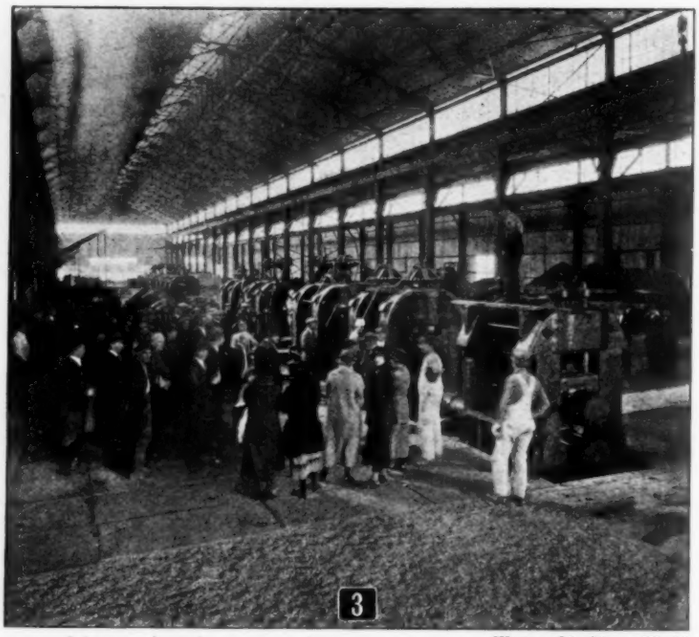
The first deposit of iron ore which seems to have received attention was near Clipper Gap, in Placer county, California; this was worked in 1854. Analysis of the ore made in 1866 showed it to be a mixture of hematite and magnetite of high purity and, in 1869, a small quantity of the Clipper Gap ore was shipped to the Pacific Rolling Mills in San Francisco. In 1880 the California Iron Company constructed a blast furnace at Hotaling on the C. P. Railroad to smelt the Clipper Gap ore. The furnace was operated on pine charcoal with marble flux, using a hot blast. A total of a little more than 4,000 tons of iron was produced at the rate of 800 tons per month. After five months of operation, the plant was partly destroyed by fire and was never again operated.

At Oswego, near Portland, Oregon, there stands today an interesting monument in the form of an old stone stack, which was built during the years 1865 to 1867. This stack is 32 feet high and 9½ feet at the tuyeres; it is constructed of basalt blocks. The fuel was charcoal from Oregon fir, a hot blast was used at two pounds pressure, and the rated production of the furnace was nine tons per day. Intermittent operations were carried on until 1882. Later, a seventy foot steel stack was built on the same site and operated for two or three years, but high phosphorus troubles developed and the project was abandoned in 1895.

In 1882 a small furnace was operated at Port Townsend, Washington, with a recorded production of five tons in that year.

In 1881, a charcoal furnace was put into operation at Irondale, Washington. During the first year the production was about 800 tons. Pig iron was produced intermittently until 1904. The plant then remained idle until 1910, when the furnace was rebuilt as a coke furnace, using local coal and smelting Chinese ore. This operation continued for only one year. Finally, in 1917, the plant was bought by the Pacific Coast Steel Company, the furnace rebuilt, and the ore in the stock pile smelted. About 20,000 tons of pig iron were produced during the eighteen months of operation, then the plant was shut down and dismantled. This marks the last production of pig iron on the Pacific Coast.

Returning to California: At Heroult, in Shasta county, experiments on a large scale were made in the production of pig iron from local ore and charcoal in electric furnaces. The first furnace was started in July, 1907, but the operation was not satisfactory. Two years were spent before a successful furnace was developed by Prof. Dorsey A. Lyon, then of Stanford University, now Chief Metallurgical Engineer, U. S. Bureau of Mines. In 1908, Professor Lyon constructed a small single phase furnace, using 160 k. w., and producing one ton of iron a day. This was followed, in 1909, by a furnace of 1,500 k. w. capacity. In 1911, a similar furnace of 2,000 k. w., was installed, followed by one of 3,000 k. w. in 1912.



Western Machinery World

The new Pittsburg, Calif., sheet mill. Three railways enter this building to facilitate the handling of incoming and outgoing material.

In 1914 the production of pig iron was discontinued when the power rate was raised from $12.00 to $25.00 per h. p. year. When the production of pig iron became commercially impossible, the Heroult plant was used for the making of ferro-alloys. During the World War a good grade of ferro-manganese was produced.

Finally, in 1918, a 1400 k. w. furnace operated a short time making pig iron, at the rate of twelve tons a day, which cost a little over $27.00 a ton. Not being able to compete with imported pig iron, the project was abandoned. The Columbia Steel Company has in operation at Provo, Utah, a blast furnace and by-product coke oven, the first unit in an operation to develop its iron ore and coal mines in Utah. Pig iron from this furnace is being shipped to Pacific Coast consumers. While this furnace is east of the Sierra Nevada Mountains, it is strategically important. This comprises a rough outline of the production of pig iron on the Pacific Coast.

All civilized communities are producers of a certain amount of scrap iron and steel. This statement has become markedly true in the last few years, since the advent of the automobile; even apart from the automobile, all machines and implements built of iron or steel eventually wear or rust out and become unserviceable. This iron metal scrap material may be re-made into useful shapes again by various processes, one of the simplest of which marked the beginning of what is now the steel industry of this Coast.

Before the production of rolled merchant steel from ingots began on the Coast, the needs of the blacksmith were largely supplied by the manufacture of what is called "muck bar" or "faggot bar" iron. This is made by bundling old wrought iron and soft steel scrap into "faggots," heating the mass to a welding heat, squeezing, or hammering into a "bloom" and finally rolling into bar iron. The Judson Manufacturing Company started operations of this character nearly fifty years ago at Emeryville, on San Francisco Bay, and continued until 1917, when the plant was converted to the manufacture of open hearth steel. By similar methods, for many years at the Sacramento shops, the Southern Pacific Railroad Company has produced busheled iron for the manufacture of tie plates. The operation has been abandoned during the last few years.

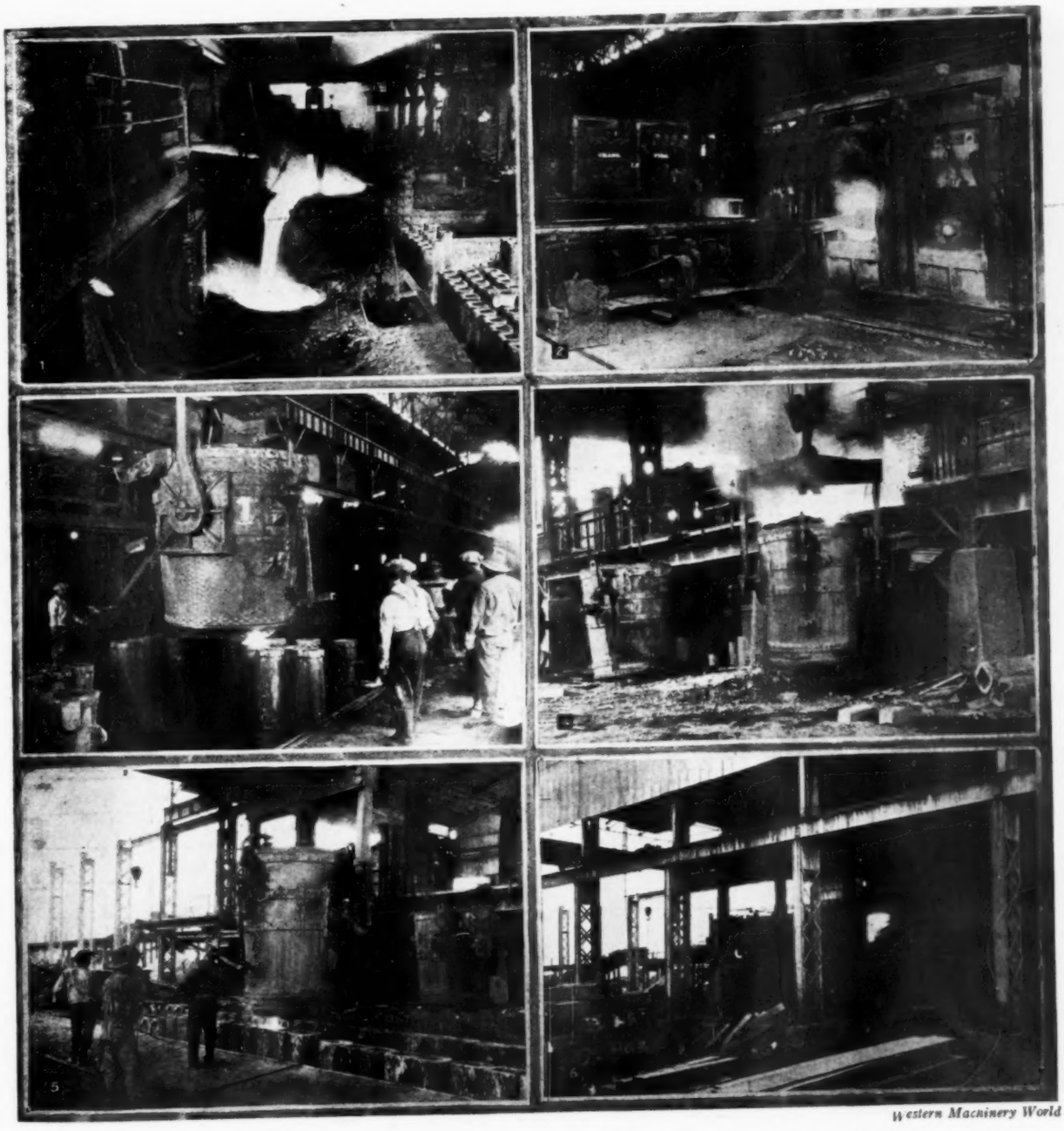
About 1895, the Pacific Rolling Mills established a scrap bar mill and built a small open hearth furnace in San Francisco, but this was abandoned in 1900. About the same time, a man named Chamberlain established a mill at Los Angeles, using scrap wrought iron plate, which was re-rolled into sheet bars. This enterprise failed, was bought by the Stewarts of the Union Oil Company, and converted into a scrap bar mill in 1902. It was operated as such for ten years, and then sold to the Southern California Iron and Steel Company, which conducted it as a muck bar plant until 1917. The plant was then equipped to make open hearth steel and is now operated by the Pacific Coast Steel Company.

In 1894, Judge E. M. Wilson, now president of the Pacific Coast Steel Company, operated an iron mill making scrap bar iron at Lakeview, Washington. Judge Wilson moved his plant to Seattle in 1904, and bar iron production was continued until 1916. At this time the plant was converted to open hearth steel production, becoming the Seattle plant of the Pacific Coast Steel Company.

In 1892, a man named Ayers built a scrap bar mill in Portland, Oregon. This was sold to the Pacific Hardware and Steel Company in 1903. Operations were continued until 1911, when the plant was purchased by the Pacific Coast Steel Company; this Portland plant is not in operation at present.

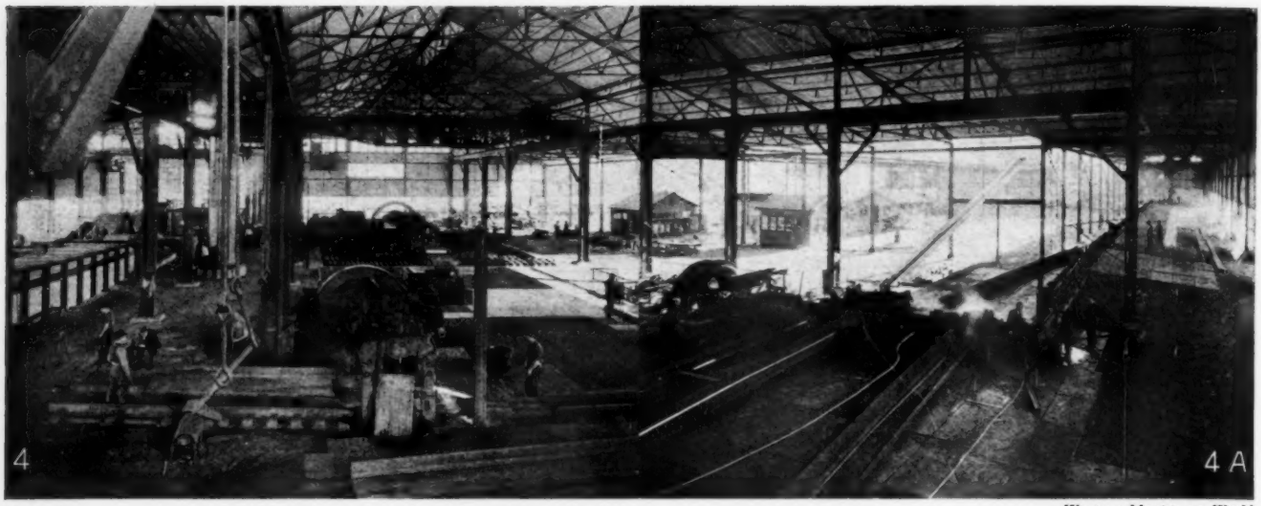
So far in the study of the history of the Coast industry it is noticeable that the beginnings were nearly always made in producing the more humble "muck bar" and in each case, as economic conditions changed and population grew, the

Open Hearth Furnaces in Southern California



Western Machinery World

Fig. 1. Pouring off the slag from a tapped heat at the plant of the Columbia Steel Corporation, Torrance, Cal. Fig. 2. Charging an open-hearth furnace at the Columbia Steel Corporation's Torrance plant. Fig. 3. Pouring the last of the heat into ingot molds at Torrance. Fig. 4. A heat just tapped at the plant of the Southern California Iron & Steel Co., Los Angeles. Fig. 5. Pouring into the ingot molds at the plant of the Southern California Iron & Steel Co. Fig. 6. Looking into the open-hearth furnace plant of the Southern California Iron & Steel Co., giving a very good idea of the type of building construction required for such a plant, where no provision need be made for climatic conditions.



Rolling mill department, Columbia Steel Corporation.

Western Machinery World

Rod mill at Pittsburg plant,, Columbia Steel Corporation.

"muck bar" plants were converted into steel plants. These plants have come under the control of three main operators: The Columbia Steel Corporation, the Pacific Coast Steel Company, and the Judson Manufacturing Company.

Twenty-six years ago, in 1900, the Columbia Steel Company established a steel casting plant at Portland, Oregon. Pig iron was converted into steel in a Tropenas surface-blown converter. Several years after, they moved to Pittsburg, California, about one hundred miles north of San Francisco. In 1920, Pittsburg, California, became one of our Coast steel centers when the Columbia Steel Company built its present open hearth plant and rolling mills.

In 1906, Rudgear Merrill Company constructed an open hearth furnace and rolling mill in San Francisco. They used a scrap charge and produced bed angles. Later, the open hearth process was abandoned and old railroad rails were

Materials and Transportation to Make One Ton of Finished Steel

ITEM	Amount per ton of finished steel in pounds	Origin	TRANSPORTATION			
			Rail Miles	Water Miles	Ton miles per ton finished steel Rail	Ton miles per ton finished steel Water
Fuel oil	72 gallons	Cal.	.....	50	.....	14.4
Scrap	2149.8	Cal.	200	.....	215	.....
Pig Iron	88	Utah	800	.....	35.2	.....
Ferro Manganese	11	England	11	8,000	0.06	44
Ferro Silicon	7.5	New York	11	4,700	0.04	27.6
Manganese ore	10	China	11	11,000	0.05	55
Iron ore	11.8	Cal.	300	.....	1.7	.....
Aluminum	0.7	Local scrap	11	.....	0.004	.....
Coke	89.7	England	11	8,000	0.05	535
Limestone	156.3	Cal.	130	.....	10.1	.....
Fluorspar	9.7	China	11	11,000	0.05	53.0
Magnesite	8.5	Cal.	300	.....	1.27	.....
Dolomite	102.9	Cal.	106	.....	5.45	.....
Chrome ore	2.0	New Caledonia	11	14,000	0.01	14.0
Moulds	35.2	Ohio	11	4,500	0.19	79.2
Brick	38.0	Penn.	11	4,500	0.21	85.2
Rolls	5.6	Penn.	11	4,500	0.03	12.6
TOTAL					269.4	738.0

Western Machinery World

Wire-drawing department, Pittsburg, Calif., consisting of forty 24-inch, eight 20-inch, twenty-four 16-inch, and twelve 8-inch blocks.

split and re-rolled into concrete bars. This enterprise was driven out of business, about 1913, by the local competition of specification steel.

In 1910-11, the South San Francisco plant of the Pacific Coast Steel Company was built. The first heat of steel was poured on January 2, 1912, and was analyzed by the writer. When built, the plant consisted of two small open hearth furnaces, one acid and one basic; the acid furnace was never operated as such, but was later converted to the basic process. The mill consisted of a 22-inch blooming mill and a 10-inch finishing mill, while the product was almost entirely concrete bar, which was in great demand at the time for the rebuilding of San Francisco after the earthquake. Much of the scrap charged to the furnaces was from earthquake wreckage.

In 1916-17, the Llewellyn Steel Plant, consisting of open hearths and rolling mills, was built in Los Angeles. This plant is now the Los Angeles plant of the Columbia Steel Corporation.

All of these operations have now been consolidated; the Pacific Coast Steel Company has operating plants in Seattle, South San Francisco, and Los Angeles, with a stand-by plant in Portland. The Columbia Steel Corporation operates steel mills and furnaces in Pittsburg and Los Angeles. The Judson Manufacturing Company operates a plant at Emeryville, near San Francisco.

The Industry Today

In order to justify the existence of a steel industry on the Coast, from a purely ordnance point of view, it would seem necessary to show that the railroad mile haul of the raw materials to produce one ton of finished steel must be less than the railroad haul of one ton of finished steel from some large center, say Pittsburgh, Pa., to San Francisco. In order to make this comparison, a study was made of the operations for the first six months of this year at one of the larger plants on the Coast. The information concerning this plant, which is believed to be representative, is shown in tabulation on the preceding page.

It may be seen that the ton miles of rail haul per ton of finished steel produced is only 269.4 against a ton mileage of about 2,500, if the finished steel were hauled from Pennsylvania. This would seem to justify amply the existence of the Coast industry in time of emergency, when rail transportation would be at a premium.

It is of interest to note what would happen in time of emergency if this nation should lose, temporarily or permanently, the control of the sea. The items in the tabulation which would be affected are ferro-manganese, ferro-silicon, manganese ore, coke, spar, and chrome ore; these raw materials are at present obtained from over-sea sources.

Ferro-silicon and ferro-manganese could be replaced by a silico-manganese alloy produced locally in electric furnaces from California ores; this was done, to some extent, during the last war. The use of manganese ore is not essential to the steel making operations, while a supply of coke could be obtained from the state of Washington, and flourspar could be received from New Mexico. Chrome ore can be, and has been, obtained from local deposits close to San Francisco. Other items which are at present transported by water from eastern states would have to be hauled by transcontinental freight.

Under the conditions just mentioned, that is, complete rail haul of raw materials during an emergency in which control of the sea had been lost, it is estimated that the ton miles of rail haul per ton of finished steel produced would be about 333. The requirements of electric power are 50 k. w. h. per ton of steel produced; this item is well taken care of in California.

Plant Descriptions and Capacities

Pacific Coast Steel Company

Seattle Plant.—The Seattle plant of the Pacific Coast Steel Company is located at Youngstown, a suburb of Seattle, Washington, and is equipped with four open hearth furnaces of 45 gross tons capacity each. The steel is cast into ingots, the largest size being 12 by 24 inches. These ingots are broken down in a 22-inch mill and the various sizes are finished in 16-, 12- and 9-inch mills. The plant is also equipped with a plate mill, which produces a full range of universal plates up to 24-inch widths. The total capacity of the plant is 150,000 tons per annum, and the largest sizes of shapes and bars produced are 10-inch channels, 6 by 2-inch flats, 8-inch beams, and 6-inch angles.

South San Francisco Plant.—The South San Francisco

plant of the Pacific Coast Steel Company is situated at the town of South San Francisco, about 11 miles south of San Francisco. This plant is of somewhat similar capacity to the Seattle plant: four 50-ton basic open hearth furnaces are in operation, casting ingots up to 12 by 14 inches. The steel is broken down on a 24-inch mill and, for large sections, is directly finished on an 18-inch mill. Smaller sizes are rolled from billets on 12- and 9-inch mills. Bars and shapes are produced up to 6 by 6-inch angles and 3½-inch rounds. A considerable tonnage of heavy sheet bars is also rolled for the Pacific Sheet Steel Corporation. The tonnage capacity of the plant as a whole is 150,000 tons per annum. A feature of this plant is the operation of a large structural shop in which complete electric power transmission towers are fabricated and galvanized.

Los Angeles Plant (Southern California Iron and Steel Company). — This plant is located at Huntington Park, a suburb of Los Angeles. Here three basic open hearth furnaces of 35 gross ton capacity are operated, casting 10 by 10-inch and 12 by 12-inch ingots for rolling, and 26 by 26-inch ingots for forging. The plant is equipped with 22-, 16- and 12-inch mills, producing bars up to 6 by 2-inches, but no shapes. The large ingots are forged in a 1,000 ton hydraulic press, which is served by two heating furnaces. Large shafts and forgings are produced in this manner from plain carbon and alloy steels. A bolt and nut shop is also operated having a monthly capacity of 1,200 tons. The tonnage capacity of the plant as a whole is 60,000 tons per year.

Western Machinery World

View in the sheet mill department, Columbia Steel Corporation, Pittsburg, Calif., plant, showing annealing boxes and covers.

Columbia Steel Corporation

Pittsburg Plant.—The main plant of the Columbia Steel Corporation is located at Pittsburg, California, about 100 miles north of San Francisco. Steel is made in two 23-ton basic open hearths, one 7½ ton acid, and two 65 ton basic furnaces. The steel is cast into 12 by 12-inch ingots weighing 2,340 pounds each, and also into 9 by 9-inch ingots weighing 1,235 pounds each. The net capacity of all furnaces is 12,000 tons per month.

The steel is broken down on a 26-inch blooming mill, which serves an 18-inch mill producing sheet bars and also billets for a 12-inch merchant Belgian type mill. The products are bars up to 1½-inch square, rounds up to 2 inches, flats up to 2½ by ¾-inch.

The plant is so arranged that the 12-inch merchant mill, together with six additional stands, makes up a rod mill having a capacity of 3,300 net tons a month, working one 8-hour shift 25 days a month. The products of this mill are No. 5 to 5/16-inch rods of mild steel, high carbon steel and pure copper.

Well equipped wire and nail mills are also operated. The wire mill has a capacity of 3,000 net tons per month, running 24 hours a day for 25 days a month. This produces wire of the following kinds: common, bright market, tie, basic, welding, spring, strand, pipe winding, stove, barb, pure copper ⅝-inch to No. 22, and twisted splice hoops.

The nail mill consists of 68 nail machines and one staple machine having a daily capacity of 2,000 kegs. Two nail galvanizing machines and two machines for cement coating and bluing are also operated. The plant has a sheet mill department which will be described later.

For the production of commercial mild and alloy steel castings from 1 pound to 80,000 pounds, a well equipped foundry is maintained. The operation of this foundry started in November, 1910, and it has a net capacity of 1,500 tons a month.

The Pittsburg plant of the Columbia Steel Corporation has a total capacity of 144,000 tons per annum and produces a great diversity of products, but does not ordinarily produce the larger sizes in shapes and bars.

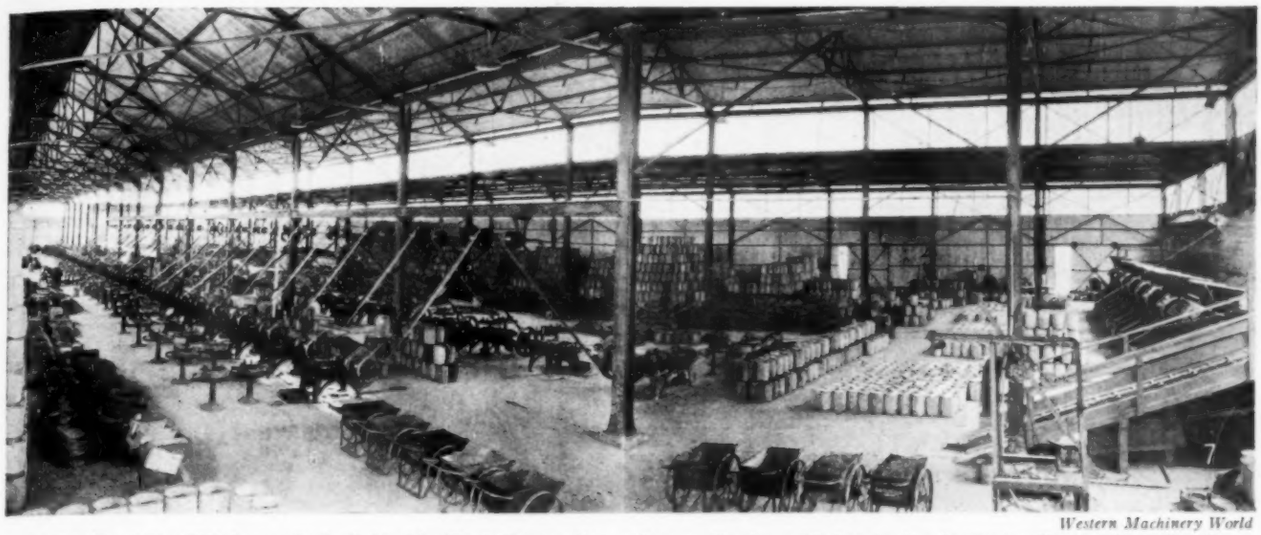
Llewellyn Plant. — This plant is operated by the Columbia Steel Corporation at Torrance, California, a suburb of Los Angeles. Two 40-ton basic open hearth furnaces are operated and the steel is rolled on 22-, 16- and 12-inch mills. The product of the plant is largely angles, shapes and bars. Up to 6 by 6-inch angles can be rolled. The total yearly capacity of the plant is 40,000 tons.

Provo (Utah) Plant.—One blast furnace with by-product coke ovens was placed in operation in 1924. The furnace has a monthly production of over 11,000 tons of pig iron, and the coke ovens average 15,000 tons of coke per month. This plant uses iron ore and coal from the Utah mines of the company. The pig is used by the other plants of the company and is sold to Pacific Coast and intermountain foundries.

The Judson Manufacturing Company

The Judson Plant is situated at Emeryville, across the Bay from San Francisco, and was one of the first plants established in California. Three 30-ton basic open hearth furnaces are in operation. Steel is rolled on 20-, 18- and 9-inch mills. The production range on rounds and squares is from ⅜ to 3½-inch diameter, on flats up to 6 by 2½ inches and on angles up to 4 by 4 inches. Other shapes and bars are also rolled.

In addition, forging ingots in 10-, 12- and 14-inch sizes up to 16 feet in length can be produced. The plant also operates steel and iron foundries. One of the largest structural and bridge fabrication shops on the Coast is maintained, specializing on the fabricating of steel buildings, bridges, tanks, and viaducts. The total capacity of the plant is 50,000 tons a year.



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Nail mill at the Pittsburg plant, Columbia Steel Corporation, where nails from 2d fine to the largest spike are turned out.

The Manufacture of Sheet Steel

Two sheet steel plants are in operation on the Coast. One plant is operated by the Columbia Steel Corporation in connection with their Pittsburg plant and the other by the Pacific Sheet Steel Corporation at South San Francisco.

Columbia Plant.—The first sheet steel mill west of the Mississippi was started in operation at Pittsburg, California, on March 13, 1924. The mill consists of five jump roughing, five finishing stands, and two cold-rolled mills with Hagan continuous pair furnaces, Furnace Combustion Company's sheet and annealing furnaces, and United Engineering and Foundry Company's mills and auxiliary equipment. It is a 30-inch mill having a monthly capacity of 3,500 tons. The galvanizing department contains two pickling machines and two continuous galvanizing machines. The capacity for galvanized sheets is 2,000 tons per month.

The sizes produced are 14 to 30 gage, 40 inches wide and 144 inches long. The products are black anneal, flat and corrugated galvanized, box anneal and deoxydized sheets. The Columbia Steel Corporation rolls its own sheet bars.

Pacific Sheet Steel Corporation.—The plant is situated near the South San Francisco plant of the Pacific Coast Steel Company, which furnishes the sheet bar. The plant started operations on April 14, 1924, and at the present time there are in operation four hot mills, one using 44-inch to 56-inch rolls and the other three, 38-inch to 48-inch rolls. There are two stands of cold rolls, a continuous annealing furnace, eight box anneal furnaces, two galvanizing machines and the necessary auxiliary equipment.

A complete suite of sheet products is produced, including black, enameling, corrugated, galvanized, high carbon blue anneal, copper bearing galvanized and copper bearing blue annealed sheets. The sizes rolled are from 7 to 30 gage, from 48 to 24 inches wide and from 96 to 144 inches long.

The Coast steel industry may then be summarized as having 21 operating open hearth furnaces with a yearly capacity of 610,000 tons of steel with 21 operating rolling mills producing all sizes and shapes up to 6 by 6-inch angles and 3½-inch rounds. Such capacity is, of course, more than ample to supply any demand which might be made on the Coast industry in time of emergency, but it must be remembered that the sizes of rolled products which have been indicated are the maxima which can be expected to be satisfactory for Ordnance purposes.

SUMMARY OF MILLS AND FURNACE CAPACITY

PLANT	FURNACES		Yearly capacity tons	Size of mills	No. mills
	No.	size			
Pacific Coast Steel Company, Seattle	4	45 tons	150,000	22″, 16″, 12″, 9″	4
South San Francisco	4	50 "	150,000	24″, 18″, 12″, 9″	4
Los Angeles	3	35 "	60,000	22″, 16″, 12″	3
Columbia Steel Corporation, Pittsburg	2 1 2	23 " 7½ " 65 "	150,000	26″, 18″, 12″, 12″	4
Los Angeles	2	40 "	50,000	22″, 16″, 12″	3
Judson Mfg. Company	3	30 "	50,000	20″, 18″, 9″	3
Totals	21	furnaces	610,000		21

John M. Browning

1855-1926

OLD John Browning has passed on. The foremost inventor of automatic weapons in history and one of the greatest inventors of small arms, has finished his three-score years and ten; but leaves behind him a monument of industry and accomplishment that generations yet to come will see.

Mr. John M. Browning, inventor of the world-famous Browning machine guns, was born in Ogden, Utah, in June of 1855. His father before him was a gunmaker of the old school, and little John was brought up in his father's gun shop and had the old lathe and the scrap heap as his companions. He also had as companion his brother, Matt, and as the boys grew older they outstripped their father in his art of rifle making. Before John was twenty-five he perfected a single-shot rifle according to his own liking and, with Matt, managed to turn out and sell five or six hundred of them.

JOHN M. BROWNING
Inventor of Small Arms and Automatic Weapons

About 1885, one of these rifles fell into the hands of Mr. T. G. Bennett of the Winchester Repeating Arms Company, who was so impressed by the simple and effective design of the arm, that he forthwith made a trip to Ogden and to the surprise of the Browning brothers paid them large royalties to allow the Winchester Company to produce this rifle. And the company is still producing it!

The business ability of these two young men was not wanting and they soon organized themselves as the Browning Brothers Company. John seemed to furnish the inventive genius for the partnership and Matt was not at all lacking in business ability. Between them they thrived and prospered, branched out from the gun business to banking and stock raising, and their estates are now rated in the many millions. Mr. Browning's association with the Winchester Company led him to go from single-shot rifles to repeating rifles and shotguns. He designed also for the Remington Company and the Stevens Company, and became interested in the Fabrique Nationale of Liège, Belgium. But his longest and last association in this country was with the officials of Colt Patent Fire Arms Manufacturing Company, with whom he worked for many years. He was with them when the World War began and when the United States cast its lot with the Allies. He was with them when war found our nation with a woefully insufficient supply of machine guns and no automatic rifles whatever. He was with them in May, 1917, when the Secretary of War ordered a Machine Gun Board to test all machine guns and automatic rifles submitted to it.

For these tests, which were held at Springfield Armory, Mr. Browning submitted through the Colt Company, two guns, one the heavy water-cooled Browning machine gun, and the other, the light Browning automatic rifle. Mr. Browning demonstrated these guns himself. During the tests he refused to become agitated or excited, was very placid, very slow and deliberate in his movements, was not perturbed at slight irregularities, and throughout gave an air of quiet and absolute confidence in his guns and in the final outcome of the test.

The trial, indeed, left no doubt in any man's mind; the Browning machine gun and the Browning automatic rifle were proved to be superior to anything else tested or known, and the Board so declared. The training of a six-million-man army, the manufacture of the machine gun equipment for this army, and the service of this equipment in warfare, showed that the Browning machine guns fulfilled their best expectations. The designs were so simple and the manufacturing cuts so skilfully planned that fabrication proceeded at an unheard-of rate, and if the War had continued, it can be surmised that the Browning guns, manufactured in the United States, would have been largely supplied to our Allies.

Mr. Browning was most modest and unassuming. His name was not attached to any of his rifles until the advent of the last Browning machine gun, though he was the inventor of innumerable sporting arms, of the old Colt machine gun, and of the Service automatic pistol.

A most likable man, a cheerful companion, a wonder mind for arms invention, he has passed on, leaving us to marvel at his ability and to be inspired by his simple and lovable character.

Earl McFarland,
Maj. Ord. Dept., U. S. A.

Western Machinery World

The Golden Gate across San Francisco's waterfront.

Western Industrial Development

C. A. Handschin

THE people of the Pacific Coast are apt to be looked upon as boosters whenever they begin to describe the region in which they dwell or any of the factors which combine to make that region such a favorite spot. This has come to be such an accepted viewpoint by the Easterner that there have been coined certain phrases in regard to it which seem to stick and any one who tells a story concerning this part of the world is apt to be dubbed a Californiac.

Notwithstanding this attitude on the part of some of the inhabitants of the rest of the United States, and even Europe, when we apply the acid test of investment to the projects of the West, we find that the most hard-headed of eastern bankers are in a large measure willing to invest their funds, and those of their clients, in bonds and stocks secured by the industrial properties of this western country. In no class of investments is this so apparent as in the big hydro-electric projects already established or outlined for the future.

This attitude on the part of the eastern capitalists is very encouraging to the Westerner interested in industrial and manufacturing plants. In the first place, the shrewd business men who are developing western power have carefully examined the present and future development in this field, and have satisfied themselves that the work and responsibility they are undertaking are justified by these developments. In the second place, their examinations into these matters has been so thorough, and their conclusions are so convincing, that they are able to put over their financial program with the most exacting of eastern bankers.

This is the most direct evidence that can be given of the faith these men have in the future growth of western industry and western manufacturing, and helps to substantiate the claims which are being made by western promoters, western machinery houses and manufacturers, and the press.

With the exception of the splendid but very limited work of the early Mission fathers, the first development of the West was occasioned by the exploitation of our high-grade placer and lode deposits, followed by agricultural development. Both have been and will continue to be the ground work of our economic structure. Here on the Pacific Coast we have a wealth and variety of raw materials that are perhaps not equalled for availability anywhere else in the world, and include such basic commodities as wool, cotton, lumber, hides, fisheries, agricultural products, ranging from semi-tropical fruits to hard wheat, zinc, lead, copper, ceramic materials and refractories of all sorts. Of paramount importance is the assured supply of iron available from Utah. Even the raising of the highest quality silk is not only a possibility but a very hopeful probability.

In a region of such vast and varied material wealth, it is natural to look for healthy growth in population, business and industry. We find on examination of statistics that in the decade prior to the World War, such growth was going on at a very satisfactory normal rate.

During the war, here as elsewhere in the United States, there was abnormal development of manufacturing plants, and many wise people shook their heads very solemnly and

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The City of Seattle from Elliott Bay.

predicted great disaster when the inevitable slump should come with the process of getting back to normal after the war. The slump, when it did come, was not nearly so large as these wise people had expected it to be. In fact, much to the surprise of many of the authorities on industrial matters, the slump was very much less marked on the Pacific Coast than in any other region in the world. Taken in combination with the great demand for timber, agricultural and horticultural products, and the enormous increase of the output of oil in California, the slump so far as all around prosperity is concerned, may be said to have passed over California, and in great measure the entire Pacific Coast. We are witnessing many indications which go to show that eastern capital and western enterprise are once more to be united in the complete development of the great industrial and manufacturing program for this favorite western region.

Our labor supply is ample and extraordinarily efficient, for while the man hour wage may be slightly higher than paid in the middle West or Atlantic seaports, the labor cost per unit of production, the true basis upon which to make comparison, is much lower than elsewhere. This fact has been definitely proved by practically all of the large concerns having branch plants in the Bay region.

Three transcontinental railroad systems, steamship lines to all ports of the world, and the Panama Canal, give ready access to over three-fourths of the entire population of the globe, while the San Francisco Bay is one of Nature's masterpieces as an ocean terminal. The population of California increased during the last decade 44 per cent.; that of the United States, 1.8 per cent., while the per capita wealth of San Francisco is greater by several hundred dollars than any other metropolis. The same general comparison as to purchasing power applies to the entire state of California.

The San Francisco Bay Area

San Francisco's bay area produces, according to a survey made by the San Francisco Chamber of Commerce, one-half of the manufactured output of the State of California. The value of this puts Greater San Francisco in the billionaire class, since it amounted to $1,379,000,000 in 1925.

The area so often spoken of as the San Francisco Bay area is composed of the five Bay counties of San Francisco, San

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The Smith's Cove Piers at Seattle.

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Automatic Screw Machine Department, Mann Manufacturing Company, Berkeley, California.

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Gear cutting department of the Mann Manufacturing Company, Berkeley, California.

Mateo, Alameda, Marin, and Contra Cost, having a total of 2,464 square miles.

San Francisco proper covers 42 square miles but its industrial production for 1925 amounted to $529,000,000, or one-fifth of the total production of the state. In connection with the growth of industry, which has been so marked in and around San Francisco, it is interesting to note that San Francisco has been growing by leaps and bounds in all the fundamental factors. For instance, during the twenty years since the San Francisco fire the city's bank clearings have increased 374 per cent., putting San Francisco in the fifth place among all the cities of the nation, her clearings now amounting to nearly $10,000,000,000 annually. The value of manufactured products has increased 287 per cent.; the value of foreign commerce 298 per cent.; savings bank deposits 318 per cent.; postal receipts 441 per cent., etc.

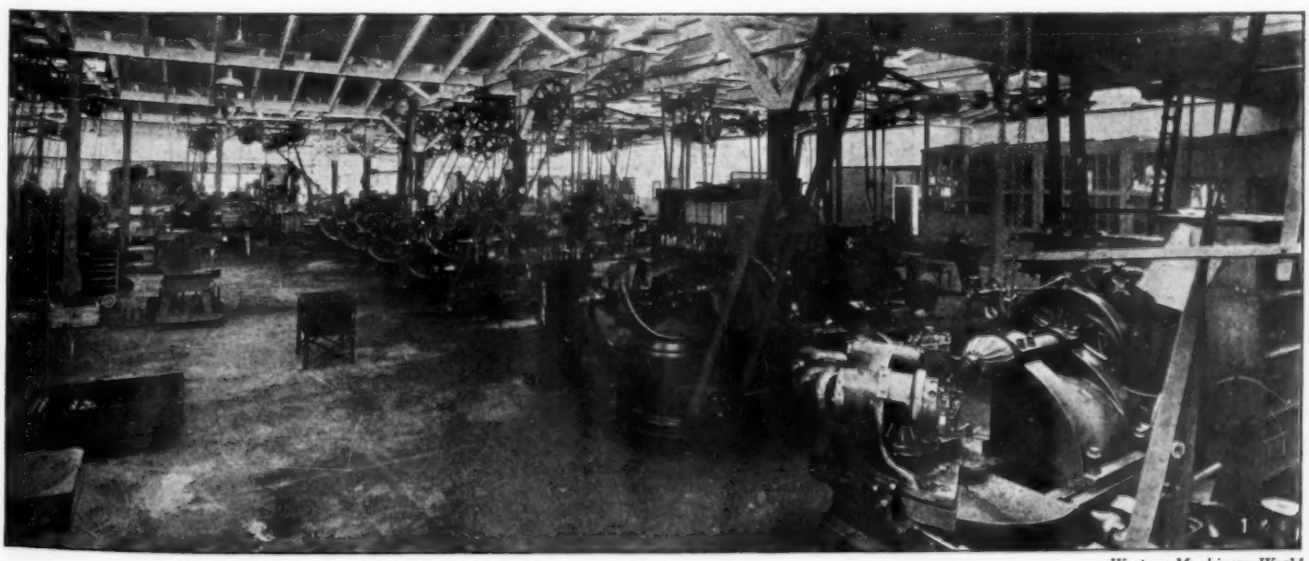
Among the reasons apparent for San Francisco's sound industrial growth stand out prominently her unexcelled distribution facilities. In the first place, San Francisco is very near the population center of the Pacific Slope, which is comprised of the eleven western states. Then it is the terminus for the seven rail lines serving this section, besides being a port of call for practically every boat afloat on the Pacific, and the home port for some of the largest steamship lines.

San Francisco is known widely as a city of diversified industry. Often a town or city is dominated completely by one industry, such as paper making, or shoes, or textiles. This condition means that the entire town reflects the ups and downs of the dominating industry. But in San Francisco no one industry dominates the situation, although in several lines San Francisco is the recognized center for the Pacific Slope. An even prosperity prevails in San Francisco at all times, because at no one time is a slump felt in all industries, the city never experiencing a general depression.

Some of the lines of industry of which San Francisco is the center for the Pacific Coast are:

The furniture industry, San Francisco having, in addition to her 69 furniture factories, the largest and finest Furniture Exchange west of Chicago.

The apparel manufacturing center with a new 11-story



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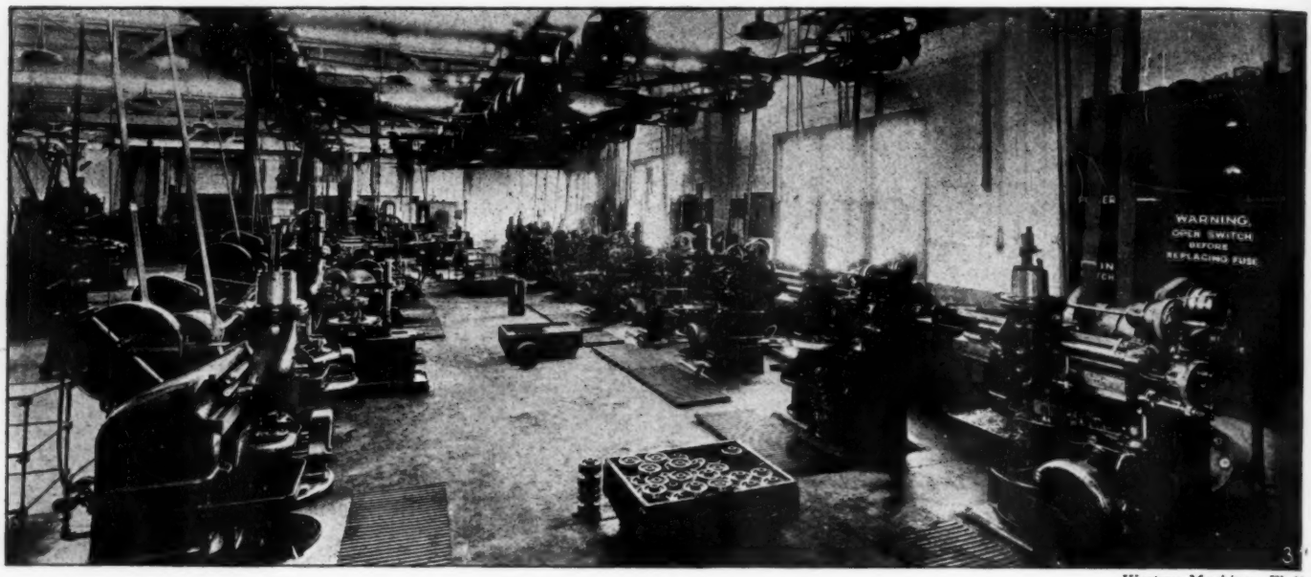
A battery of Gleason bevel gear generators in the gear cutting department of the Johnson Gear Works, Berkeley, California.



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A battery of Fellows gear shapers at the plant of the Johnson Gear Works, Berkeley, California.

Apparel Center Building just being erected to provide a market center for this growing industry.

The sugar industry, the only sugar refineries on the Coast being here, one of which is the largest in the world.

The coffee industry with 20 coffee roasting establishments in San Francisco. San Francisco has become so well recognized nationally as the western coffee center that the United States Government has recently ordered that all bids for coffee ordered by the Navy shall be opened in San Francisco.

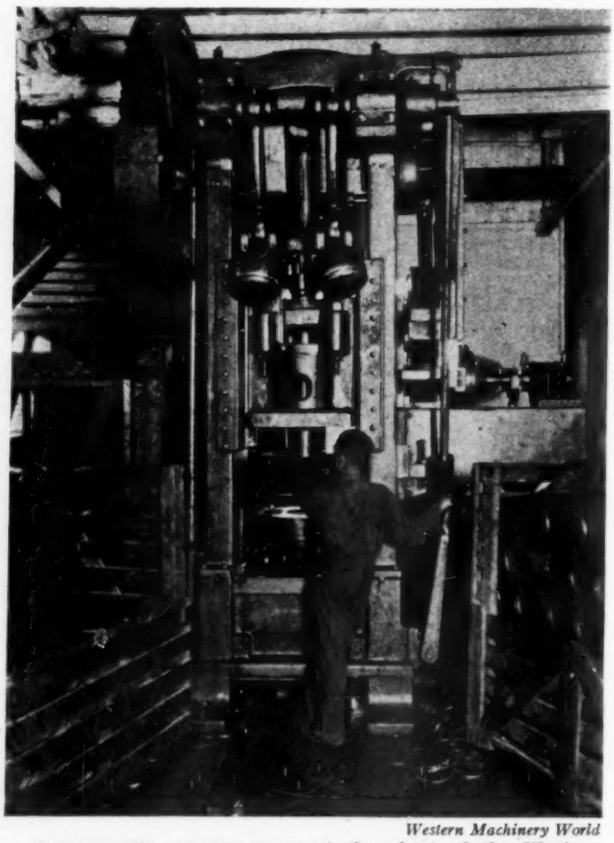
The bag industry, San Francisco having four out of the seven bag factories on the Coast.

The steel industry, with largest mills on the Coast.

This list could be extended indefinitely, taking up line after line in which San Francisco is the manufacturing center, an enumeration which would lead us all the way from chocolate and salt to tennis rackets and savings banks.

From another angle let us consider just two industrial groups in order to obtain some idea of the diversity of San Francisco's payroll. For instance, the food industries number 418, with 7,295 employees receiving $9,500,000 in wages, turning out a product valued at $108,687,000, while the metal industries number 562, employ 7,017 people, to whom a wage is paid of $10,555,000, and a product is turned out to the value of $47,000,000.

Greater San Francisco has a population of 1,250,000, a payroll of $200,000,000, and produces an industrial output valued at $1,379,000,000.



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A large Bliss toggle press at the plant of the Western Aluminum Company, Oakland, which could be used for the manufacture of steel helmets. This press weighs 39,500 lbs. and is capable of turning out 5,700 large pieces per day. Thirteen other presses at the same plant have an equally large production capacity.

Oakland, the East Bay Manufacturing Center

According to an article by Gilbert E. Keitle published in the August, 1926, number of *Western Machinery World*, few communities on the Pacific Coast have experienced a greater growth during the past ten years than has the city of Oakland, California.

Less than 100 years ago Oakland was but a part of a great Spanish ranch. Sixty years ago it was a sleepy village. As recent as 15 years ago the advance had little more than started. Today there are more than 300,000 people in Oakland proper, and nearly a million in the surrounding area, which has been aptly termed "the great East Bay."

Located as it is on the continental side of San Francisco bay, it is natural that Oakland is the western terminus of three transcontinental railroads, and one intra-state electric line. It is also a port of call for steamer lines serving Atlantic, Gulf, Mexican, South American, European and Oriental ports.

Within a 40-mile radius of

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Interior views at the plant of the Llewellyn Iron Works, Los Angeles, showing parts of the machine and structural steel shops.

Oakland are 1,460,000 people. The population of the 11 western states at the present time is something over 10,000,000. Oakland is nearer this market than any other important distribution point. National manufacturers have recognized the distributing advantages of Oakland as is attested by the fact that more than 100 such firms have already located their western plants in the East Bay territory.

The list of these reads very much like a list selected from "Who's Who in American Industry," containing the names of such well known firms as General Electric Company, Sherwin-Williams Company, National Lead, Peet Bros., Westinghouse Electric & Manufacturing Company, Shredded Wheat, American Can Company, United States Light and Heat Corporation, Western Electric, H. J. Heinze Company, General Motors, Durant Motor, Willys-Overland, Fisher Body, Fageol Motors, Caterpillar Tractor, the Hall-Scott Motor Company, Montgomery Ward & Company, and others.

These industries have found in Oakland, besides an ideal distributing point, a splendid year-around working climate. Many of them report that their Oakland branches are able to operate much more efficiently than the home plant by reason of the better climatic conditions.

California has an abundance of raw materials necessary for the development of her thousands of diversified industries, and Oakland, due to its geographic location, is near to these raw products.

Oakland is also near the mineral resources of the state, chief among which are quick silver, cement, magnesium salts, calcium chloride, potash, manganese ore, gold, silver, copper, petroleum, natural gas, lead, and zinc.

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Some of the drop forge equipment of the Western Drop Forge Company, Los Angeles.

Oakland harbor is exceptionally favored for handling of timber products as evidenced by the fact that some 230,000,000 feet of lumber are handled over the docks each year.

Four of the largest oil refineries in California are located in the East Bay district and supply fuel to manufacturers at a low cost.

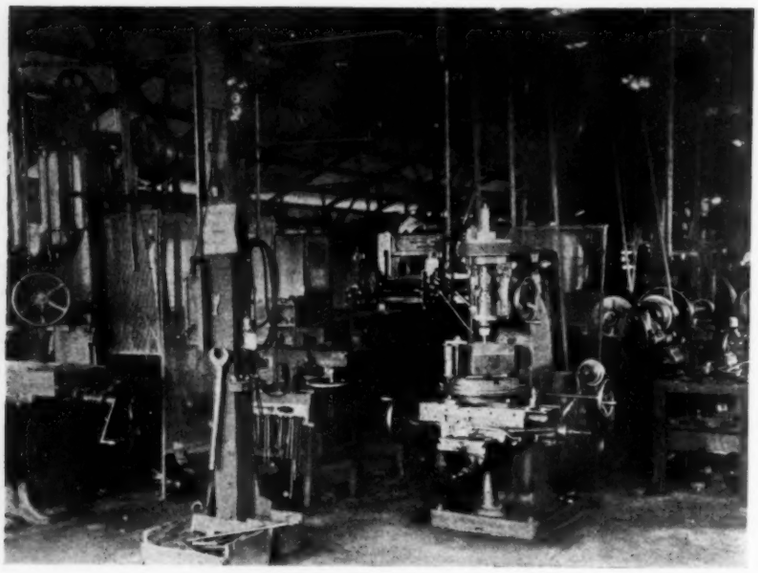
Nature was generous in equipping the city with 27 miles of water frontage which, according to port authorities, has promise of being one of the largest harbors in the world.

Ships from other ports entering the Golden Gate continue across San Francisco bay about four miles to meet the three transcontinental railroads. Oakland thus has the great advantage of being the point of contact for rail and sail.

The United States government has spent over $5,000,000 in giving the city deep water. Municipal and private interests have invested an equal amount or more and at the present time the city is embarking upon a program of development approximating $10,000,000, which was voted overwhelmingly by the citizens at a recent election.

Since 1920 the East Bay district has experienced a steady, continual and diversified industrial growth. The rapid increase of population in California and other Pacific Coast states, and the growing markets of the counties bordering the Pacific Ocean have made it possible and profitable to manufacture on the Pacific Coast rather than serve this market from eastern and middle western states.

The automobile industry alone in the East Bay represents a capital investment of more than $15,000,000, furnishes employment to more than 5,000 people, and turns out products valued at $80,000,000 annually.



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A corner of the machine shop for the manufacture of drop forging dies at the plant of the Western Drop Forge Company, Los Angeles.

There are more than 40 manufacturing, assembling and accessory plants in the automotive group.

The years 1923 to 1925 have seen the greatest industrial expansion in the East Bay, a total of 125 plants locating in each of those years. During the latter year, in the metal trades alone 19 industries located in the Oakland district. These include firms manufacturing metal castings of all kinds, electric shop tools and equipment, refrigerating equipment, pipes, boilers, plows, canning machinery, oil burners, lawn sprinklers, aluminum wheels, metal garages and other products. Oakland is the recognized home of marine diesel engine plants, represented by five factories, all of which are experiencing a rapid growth.

The most recent figures on industry in the East Bay reveal that there are 1,075 plants operating, employing some 43,000 people. The products of these plants during the year 1925 were valued at $337,909,692. These industries have invested in land $20,389,698, in buildings $32,003,853, and in equipment $59,321,363, making a total investment of $111,714,914.

When it is considered that in 1920 there were but 593 establishments in the same territory, employing some 23,000 people, some idea of the vast strides that are being made can be seen. At that time the value of the annual output was placed at $134,755,000.

The Industrial District of Los Angeles

Industrial payrolls in the Los Angeles district are producing manufactured goods having an annual value of over $1,300,000,000. This represents an increase of more than $25,000,000 in the value of these products as compared with the same period for 1925. The volume of production and the variety of products undeniably stamp the Los Angeles area as one of the principal industrial sections of the country.

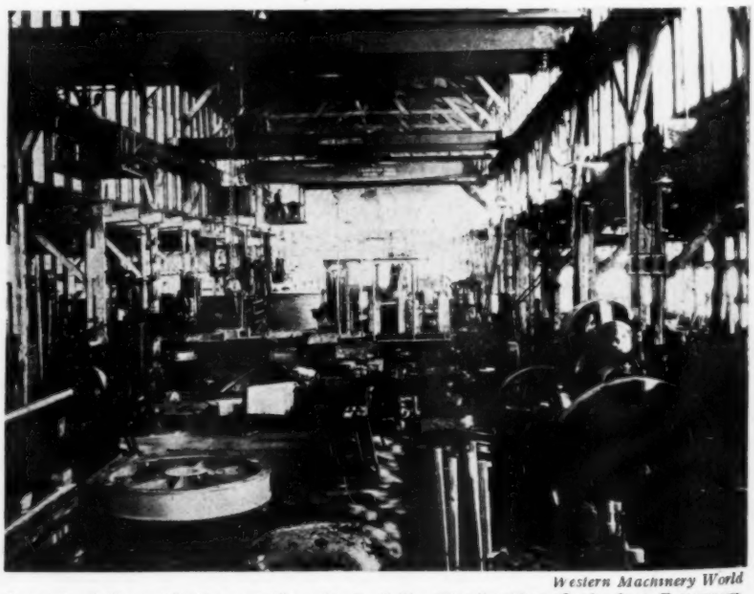
Growth in manufacturing industry within the Los Angeles metropolitan area during the six months ending June 30, 1926, included some 150 new factories and approximately 50 branch warehouses. New factories embraced 60 various kinds of products. Added to these, there were many expansions of established industries during the period.

Notable among the new industries which either began operations or obtained sites for manufacturing and assembling operations were the following nationally known institutions: Illinois Pacific Glass Corporation, manufacturers of bottles; Link-Belt Meese & Gottfried Company, manufacturers of conveying machinery; White Motor Truck Company and Denby Motor Truck Company have plants for assembling motor trucks and busses; James Graham Sons, manufacturers of stoves; Cadwallader-Gibson Company, woodwork; Hammer-Bray, stoves and ranges; Warman Electric Foundry Company, castings for cylinders, valves, etc.; Nachman Spring Company, upholstery springs; Western Oil and Refining Company, petroleum products. Of even greater significance as to the manufacturing advantages of the Los Angeles area were the expansions made by some of the larger established industries including:

Goodyear Tire and Rubber Company, $1,000,000 unit; Paraffine Companies and American Can Company practically doubling their large plants; Kroehler's development at Inglewood, which was itself in the nature of an expansion by the larger acreage tract and buildings tripling the output of the present plant on Santa Fe Avenue, purchased a little over a year ago.

Enlargements in some instances amounting to a doubling of capacity were made the first six months of the calendar year by many additional concerns, of which the following are representative:

Pacific Door and Sash Company, by merger of 6 millwork concerns in Los Angeles area, combined capital $4,000,000; Los Angeles Pressed Brick Company by an $80,000,000 merger; Union Iron Works, structural steel, 30-acre site for



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A part of the main bay at the plant of the Hendy Manufacturing Company, Sunnyvale, California, showing a large mine hoist under construction.

new plant; Torrance Flat Glass Company, window glass; Pacific Coast Steel Company, mill warehouses and equipment; General Electric Company, new warehouse and service depot; Pacific Iron and Steel Company, structural steel; Samson Tire and Rubber Company, auto tires and tubes; Lily Foundry Company, plumbers' cast-iron products and sanitary porcelain; Madsen Iron Works, foundry and stove castings; Gaffers and Sattler, gas heaters; Douglas Company, airplanes; Pacific Gas Radiator Company, gas heating appliances; Union Oil Company, petroleum products; Ward Heater Company, floor furnaces; Axelson Machine Company, oil well tools.

Among the basic industries adapted for this city and port, the copper, iron, steel, and cotton, silk and woolen textiles would have peculiar advantages.

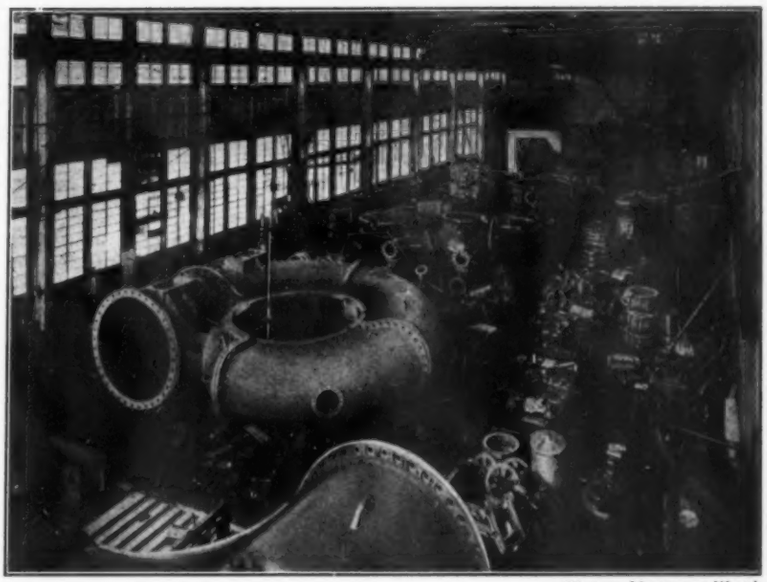
The Southern California market for refined copper now equals about 50,000,000 pounds per year and it is estimated will aggregate 100,000,000 pounds per year by 1933.

The iron and steel industry has already attained prominence, but the rolling operations are so far confined to melted scrap metal. This condition will be changed by the use of pig iron which is now being made on the Pacific Slope, with great opportunities for the economies of smelting ore at Los Angeles harbor nearest to the big market for rolled steel by the use of local ores and various tributary coking coals.

The local market for iron and steel manufacturers and machinery exceeds $100,000,000 per year.

In textiles the raw materials of cotton, wool and silk are available at lower cost here than in existing mill centers. Superior quality and extra length staple cottons produced in California, Arizona and Lower California command a premium and have attained the gross production of over 200,000 bales per annum with prospect for great development under the most ideal conditions of irrigation and freedom from pests.

The market for cotton goods tributary to Los Angeles, it is closely estimated, consists of cotton fabrics to the amount of 223,000,000 pounds valued at $125,000,000, and yarns of 124,000,000 pounds valued at $43,000,000.



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An interior view of the main machine shop of the Pelton Water Wheel Company, San Francisco.

The silk industry is singularly adapted to Southern California, since 95 per cent. of all raw silk used in America is imported through Pacific Coast ports, the material and product for Western markets being at present handled twice across the country at very high transportation charges.

That distant manufacturers must recognize their present handicaps and will ultimately be forced to embrace the economies of a plant at the focal point of their western market is evidenced by the action of over 80 nationally known manufacturing industries that have already established in Los Angeles, and is indicated by the reports obtained by personal representatives of the Industrial Department of the Chamber of Commerce on their periodical trips East.

The Chamber's industrial development program is founded upon actual and intensive work in capitalizing local purchasing power for local industries, in other words, making existing industries prosperous before inviting others. As the basis for expanded manufacturing and new factories, scientific analyses are made in the form of engineering reports of all facts regarding raw materials, potential market, economies of fabrication and distribution, and all conditions affecting profitable operation.

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Part of the manufacturing machine shop at the Fageol Motors Company, Oakland, California.

Some of the More Important Industrial Plants Allocated to the Ordnance Department for War Orders

One of the great lessons learned in the experience of the War Department is the necessity of arranging for procurement of suitable equipment and material in order to be ready for the mobilization of large armies. The War Department's organization for industrial mobilization is well known to readers of ARMY ORDNANCE, and need not be mentioned here. Personal visits have been

made to all the plants in this Ordnance District to gain first-hand information as to the present equipment and raw material available to produce ordnance equipment and to acquaint the management with the ordnance requirements.

Some of the more important plants allocated to the Ordnance Department are: The Mann Manufacturing Company, Berkeley, manufacturers of automotive parts and general machine work. With the large amount of modern machine tools installed, such as automatic screw machines, turret lathes, gear cutting equipment, grinders, etc., a wide variety of work can be handled at this plant, not only in the automotive line but also in the direction of general machine construction.

The Llewellyn Iron Works, Los Angeles, which started operation in 1886, employs approximately 1,250 workers, with an annual payroll of about $2,250,000. It has the largest technical staff on the Pacific Coast, consisting of 80 engineers. The manufacturing plant covers about 18 acres and is served with approximately one mile of standard gage track, on which are operated three locomotive trains. The various shops in the plant consist of pattern, foundry, structural, plate, boiler, machine, elevator, electrical, and forge shops. These various departments are served with 33 electric traveling cranes. Today it is considered the largest structural steel fabricator and erector, as well as the largest boiler and elevator manufacturer of the West.

The plant of the Johnson Gear Company, Berkeley, California, is one of the most modern equipped establishments for the manufacture of gears and special appliances on the Pacific Coast. The company started operation in 1905 in San Francisco. In 1920 the business had expanded to such size that larger quarters were necessary, resulting in moving the plant to its present location in Berkeley on a piece of property containing half a city block. The most modern type of manufacturing building was erected, containing the latest makes of modern machine tools for both jobbing and production gear work. The added space enabled it to expand the heat treating department so essential for the successful treatment of alloy steel. In order to manufacture gears of high quality, special gear cutting machines were installed with automatic and semi-automatic equipment for turning blanks, high grade planing, shaping and grinding equipment, in addition to pattern shop facilities. Thus the Johnson Gear Company has all the equipment necessary for general machine work requiring accuracy.

The chief products of the Western Aluminum Company of Oakland are articles manufactured from sheet metal with giant presses, automatic equipment, and special machines designed and constructed by them. In the equipment are included 15 Bliss presses, the largest of these having a weight of 40,000 pounds, and all the necessary heat treating equipment for annealing metal before and after drawing operations, spinning and polishing machines, etc. A well equipped tool room takes care of the punch and die requirements of the plant. Besides the press department, the company is operating an up-to-date aluminum foundry.

Another plant which would be valuable for the manufacture of ordnance material is the Axelson Machine Company of Los Angeles, builders of oil well pumping machines and engine lathes. This company has grown to be one of the largest factories on the Pacific Coast and occupies a floor space of over 150,000 square feet. It enjoys the unique position of being the only concern on the coast manufacturing in successful commercial quantities high grade heavy duty, quick change gear, engine lathes which are noted for accuracy, rigidity and workmanship.

The Joshua Hendy Iron Works at Sunnyvale has long been noted as one of the leading engineering institutions of the Pacific Coast. While it is perhaps best known throughout the country as a producer of mining equipment of all kinds, it builds many other lines of machinery. Its principal departments, machine shop and foundry, cover large areas of floor space, and the diversity of work to be seen in the different sections of the establishment is such as to appeal to any engineer who takes the opportunity to visit the plant.

The Western Drop Forge Company of Los Angeles, manufacturers of light and heavy drop forgings, developed from a one hammer shop to a completely equipped drop forge plant with the largest hammer capacity west of Chicago. The equipment consists of an 8,000, a 4,000, and a 2,000-pound steam drop hammer, a 1,500-pound open frame steam hammer, a 1,600 and a 1,200-pound drop board hammer, and several others, with the necessary trimming presses and furnace equipment. A large machine shop takes care of the manufacture of dies and keeps up the necessary repair work of the plant.

The Pelton Water Wheel Company was organized in 1887 for the purpose of designing and manufacturing tangential impulse wheels, and has continued throughout the years under this corporate name, expanding its service and facilities as the needs of water users made such changes necessary. It is associated with the I. P. Morris department of the Wm. Cramp & Sons Ship & Engine Bldg. Company of Philadelphia, the Dominion Engineering Works, Ltd., of Montreal, Quebec, and Sociedade Anonyma Hilpert, Rio de Janeiro.

Nearly 100,000 square feet of floor space is now in use by the company in its business, with considerable undeveloped area available for future expansion. The work done in this plant, consisting of design, manufacture and erection of hydraulic machinery requires most highly skilled engineers and mechanics, and while castings weighing up to 20 tons are machined in the Pelton shops, great precision is required.

The machine shop tool equipment comprises approximately 20 lathes of various types and sizes, 12 drill presses, 5 vertical boring mills, 4 horizontal boring mills, 4 milling machines, and other miscellaneous and special tools. All large tools are individually served with air or electric hoists for handling work, the different departments being also served with suitable cranes in addition to two large traveling cranes which serve the shop as a whole.

The principal products of the company are impulse and reaction turbines, governors, pressure sets, gate valves, butterfly valves, needle valves, Johnson valves, centrifugal pumps and deep well pumps. A 17,000 gallon testing tank is also included in the plant equipment, as well as a considerable amount of special testing equipment, with which experimental work is continually being carried on.

One of the most important and particularly well adapted plants for ordnance purposes in an emergency is the California Cap Company, which was the first American concern to manufacture detonators. The company was incorporated to carry on the business in 1880, and today a splendid plant, the outcome of this modest beginning, bears tribute to the pluck, perseverance, and foresight of the men who built and fostered it.

The factory located at Stege, on the east shore of San Francisco Bay, covers approximately 30 acres. The plant has the appearance of a trim little village consisting of one

hundred fifty buildings of various sizes, completely equipped in every detail. That so small an article of commerce as a blasting cap embodies in its manufacture a plant of such dimensions may not have occurred to the average consumer, but if one will pause to consider for a moment that the blasting cap is a vitally essential element for the firing of every high explosive blast, the existence of such a factory on the Pacific Coast, so complete in every detail that it is not dependent upon other industries for any of its components other than raw material, should be looked upon as an economic necessity to every mine operator in the West.

The many years of experience in the manufacture of industrial blasting caps and the thorough understanding of the problems involved were effectively utilized by the War Industries Board during the World War. In the early stages of America's participation in the war, it became apparent that our arsenals were not equipped to supply the later and improved types of ammunition, so the California Cap Company, without waiting for the new loading specifications then being developed in Washington, set out to design and build special machinery and to send its product to the Proving Ground for test. Meeting the most exacting requirements, it was immediately accepted; appropriations were then made to provide facilities for the production of these new types of ammunition; and the California Cap Company was chosen by the War Department to act as its agent in the administration and operation of a substantial portion thereof.

There are a great number of other industrial plants on the Pacific Coast not mentioned in this article which have the equipment and facilities to convert our unexampled national resources into finished munitions products for the national defense should the necessity ever arise.

FIRMS ALLOCATED TO THE ORDNANCE DEPARTMENT, U. S. A., IN THE SAN FRANCISCO ORDNANCE DISTRICT

CALIFORNIA:

Alameda:
Anderson Filling Machine Co., Baker Hansen Mfg. Co., Dow Pump & Diesel Eng. Co.

Berkeley:
Byron Jackson Pump Mfg. Co., Johnson Gear Co.

Burbank:
Moreland Motor Truck Co.

Emeryville:
Waterhouse and Lester, Western Aluminum Mfg. Co., Johnson Washer Co.

Fresno:
Lisenby Mfg. Co.

Livermore:
Coast Mfg. & Supply Co.

Lodi:
Vans Mfg. Co.

Los Angeles:
Axelson Machine Co., Baker Iron Works, C. F. Braun & Co., D. & B. Pump & Supply Co., Emsco Steel Products Co., Fernholtz Machinery Co., General Petroleum Corporation, W. H. Jahns, Johnson Foundry & Mach. Wks., Frank J. Kimball Co., King Machine Mfg. Co., Kittle Mfg. Co., Layne & Bowler Corp., Llewellyn Iron Works, Los Angeles Can Co., Los Angeles Spring & Forge Co., McCain Mfg. Co., Pacific Closing Machine Co., Rix Compressed Air & Drill Co., Security Mfg. Co., Southern California Iron & Steel Co., U. S. Spring Co., Inc., Warman Steel Casting Co., Western Drop Forge Co., Western Machinery Co., Wilson & Willard Mfg. Co.

Marysville:
Yuba Mfg. Co.

Newark:
Jas. Graham Mfg. Co.

Oakland:
Atlas Imperial Engine Co., Best Steel Casting Co., California Cap Co., Continental Machine Works, Thomas Day Co., Fageol Motors Co., Gilro Machine Co., Marchant Calculating Machine Co., Oliver Mfg. Co., Standard Brass Casting Co., Standard Gas Engine Co., Union Construction Co., United Iron Works.

Pomona:
Pomona Mfg. Co.

Riverside:
Parker Machine Works.

San Francisco:
American Forge Co., W. R. Ames Co., Columbia Steel Co., Cyclops Iron Works, Norris K. Davis, Enterprise Foundry Co., Giant Powder Co., Joshua Hendy Iron Works, Herrman Safe Co., Judson Mfg. Co., Larkin Specialty Co., A. Lietz Co., Link Belt-Meese & Gottfried Co., Main Iron Works, Mann Mfg. Co., Pacific Car & Equipment Co., Pacific Coast Steel Co., Pacific Foundry Co., Pacific Gear & Tool Co., Pelton Water Wheel Co., Geo. W. Pennington Sons, Inc., G. W. Price Pump & Engine Co., W. S. Ray Mfg. Co., Shreve & Co., Union Machine Co., Vulcan Iron Works, G. Weisbarm & Co., Western Can Co.

San Jose:
Anderson-Barngrover Mfg. Co., Bean Spray Pump Co., Smith Mfg. Co.

San Leandro:
Caterpillar Tractor Co.

Santa Barbara:
Westwick Iron Works.

Stockton:
Geiger Iron Works, Harris Mfg. Co., Monarch Foundry Co., Sterling Pump Works, Stockton Iron Works, Western Harvester Co.

Torrance:
Union Tool Co.

Ventura:
Ventura Mfg. & Impl. Co.

OREGON:

Portland:
Commercial Iron Works, Harris Ice Machine Works, Hesse Ersted Iron Works, Oregon Brass Works, Pacific Car & Foundry Co., Portland Iron Works, Smith & Watson, Willamette Iron & Steel Co.

WASHINGTON:

Everett:
Sumner Iron Works.

Seattle:
H. R. L. Motor Co., Isaacson Iron Works, Joseph Mayer, Inc., Precision Tool & Die Co., Johnson Mfg. Co., Seattle-Astoria Iron Works, Smith Cannery Machine Co., Stetson-Ross Machine Co., Washington Iron Works.

Spokane:
Armstrong Machinery Co., Union Iron Works.

Toluene

S. J. Dickey

CONSIDERING that at the end of the World War the large demand for toluene was suddenly cut off and that during the past interval and at present there is no great need or sufficient commercial incentive for large scale toluene production, it is well to occasionally take stock of our national ability to provide such finished material according to the delivery program that any emergency may require.

At the end of 1918 the toluene demand was being met and the necessary future estimated increase in supply assured. We must consider, however, that this was a gradual four-year development and that the increase in production from the insignificant quantity manufactured in 1914 to the maximum peak attained was not only a result of our national necessity but was initially stimulated by the commercial demand prior to our necessity. A similar time development may not be available in the future.

S. J. Dickey.

The experience gained, however, in developing such a supply will, of course, never be completely lost, although equipment constructed for the past emergency may never be available for a future one. We will be in a better position for rapidly building up a supply of such material, not only on account of the knowledge gained in the development of the past supply but also due to the commercial development of equipment and processes which, although not now being used for this purpose, are equivalent and may be turned to advantage to meet any large toluene demand. It is, therefore, the purpose of this article to briefly outline the source of toluene and the commercial developments which will be of advantage in an emergency and particularly those which have been developed on the Pacific Coast, or are at least observable to one residing there.

No attempt will be made in this discussion to go into great technical detail of toluene production and refining, but it will be more to give a picture of the future possibilities as seen by the writer, with the hopes that this article may be followed by others giving similar views of development in other parts of the country, followed with greater detail on the recovery and treatment necessary in the production of the finished materials suitable for nitration.

The readers of Army Ordnance were given a valuable and interesting outline of the production of benzol and toluol in the November-December number, 1923, by Col. Fred H. Wagner, and I would refer those interested in this subject to his article, and will not here give the characteristics, etc., of toluene other than to mention that "toluene" will here be used to mean the "C. P." finished material or its equivalent suitable for nitration, free from olefins, not containing more than 0.5 per cent. paraffins, having less than a 2 degree proper boiling range with specific gravity between 0.869 and 0.871. Toluol will be used to mean an unrefined oil having some content of pure toluene.

Sources of Toluene

The sources of toluene-bearing oils may generally be listed as follows, in approximate order of their economic importance.

1. Recovery from coke oven and city gas and their tars.
2. Special cracking of favorable oils.
3. Separation from petroleum oils having a natural toluene content.
4. Possible production by synthesis other than cracking.

At the present time we may eliminate from our consideration, insofar as the writer knows, the last two sources for production in this country. Although great commercial demand stimulates research work in new means of producing other materials, yet where this demand is not great for toluene there probably is very little research work going on, and as far as the writer knows no synthetic production has been accomplished by other than cracking, although this may have possibilities.

Examination made during 1918 of many petroleum oils in the United States showed but an insignificant occurrence of toluene in our natural petroleum. We should, therefore, eliminate this possible source from our consideration although this is understood to have some value, particularly in the handling of Borneo petroleum.

At the present time it is doubtful if there is very much production of either toluol distillates or toluene in this country from sources other than by-product coke ovens and from redistillation of tars produced in city gas plant operation. The majority of these oils now being produced it is believed are being used in the blending of petroleum gasolines for the purpose of producing motor fuels having higher so-called anti-knock value.

In an emergency, logically, the first consideration would be to divert this production for war purposes and refine the material to the necessary specifications. This would necessarily not be without some inconvenience to the motoring public, but, fortunately, other materials have been found, and more are being found with continued research, which give a similar effect in the motor and which come from other sources. In this way a substitute to make up for the benzol and toluol so withdrawn from motor fuel could be used, although manufacturing facilities for such materials might not immediately be available in sufficient capacity.

Recovery from Coke Oven and City Gas

Should this quantity of toluene thus made available within a short period be insufficient for the new demand, the next most economic source would most probably be just the same as was found during the World War, that is, the recovery of toluol distillate from city gas by the stripping or absorbtion process. Since 1918 the amount of such gas available has increased materially with the population and its consumption, which considerably increases the available supply of toluene from such a source. At the same time, developments in recovery systems made during the last seven years should increase the efficiency of separation from both city and coke oven gases and give a further increase in the supply of the finished material.

City gas is manufactured from coal and oil by several processes, and the amount of toluene available from city gas will, of course, depend on the type and methods of manufacture. Colonel Wagner has summarized the probable yield of toluene from different kinds of city gas about as follows:

By-product coke oven gas,	per	M.	cu.	ft.	0.039	gals.
Horizontal Retort gas,	"	"	"	"	.045	"
Carbureted Water gas,	"	"	"	"	.09	"

The above city gases are produced either from the carbonization of soft coal alone as in the first two listed, or from the use of coal or coke in the manufacture of blue water gas containing little or no toluene and mixing this with oil gas to produce carbureted water gas. The oil used is the principal source of toluene in this process. City gas is largely manufactured on the Pacific Coast by the oil gas process where no coal is used. In this process the oil is cracked to such an extreme amount that past examination has indicated little potential supply of toluene. This source, however, should not be overlooked in an emergency as manufacturing conditions continually change.

The methods of producing finished toluene from such city or coke oven gas may be described very briefly for those not thoroughly familiar with it. There are two general systems available for recovering light oils containing the toluene from such gas, and these may be divided into the removal by absorption, using oil as the absorbing medium, and the removing by solids as a second class, using activated charcoal or silica gel as the solid absorbing medium. The oil absorption system is by far the one most generally in use. In this latter system the gas is passed through an absorbing tower, usually up-flow, in which an oil having a boiling or distillation point higher than that of the light oil material to be recovered is passed in intimate contact with the gas, usually downwardly, and countercurrent to the gas in order to thoroughly strip the gas of constituents which can be absorbed by the oil. The oil leaving the bottom of this absorber will contain the light oil removed from the gas containing benzol, toluol, and higher aromatic oil homologues, together with similar boiling oils which for our purpose can be considered as impurities.

This absorber oil containing the light oil, which may be called a saturated or wet oil, is passed through a still where the light oil is separated from the absorber oil by the action of heat and steam. The absorber oil is then cooled and returned to the absorption tower, recontacted with the gas and in this way indefinitely circulated.

The light oil separated is then transferred to a reducing still and separated into as many of its crude component parts as the plant may be called on to produce. It may be separated, therefore, into a crude benzol, a crude toluol, crude xylol, or various solvent naptha distillates. No attempt is usually made in this still to secure extremely close boiling range material, as this is finally accomplished in a later distillation. The crude toluol is then washed with sulphuric acid to remove olefins and other impurities, the sulphuric acid sludge removed by water washing, the oil brought to neutrality by caustic soda which is finally washed from the oil by water. This treated toluol distillate is then charged to a finishing still equipped with fractionating columns for producing an extremely close range boiling point finished material. The C. P. pure toluene produced from this still is the article shipped for nitration. The process is very simple in outline, though the possibilities for difficulties and inefficiency in operation and troubles in refining are many.

Improvements in Absorption Recovery Systems

The Pacific Coast has contributed largely to improvements in oil absorption recovery systems during the last few years. This has been due not to the recovering of light oils from city manufactured gas or from coke ovens, but due to the enormous increase in the development of recovery of gasoline from natural gas using the same process.

When it is realized that the natural gas gasoline manufactured in the United States during the year 1918 amounted to only 282,000,000 gallons and that only 63,000,000 gallons of this was at that time manufactured by absorption systems, and that this has increased to 1,105,000,000 gallons in 1925, principally by the oil absorption system, it can readily be seen on what an extensive scale development and construction have been going on during the intervening period.

There are quite a few plant and equipment manufacturers on the Pacific Coast who have spent large sums in research work on the absorption system and this has resulted in greatly improving the efficiency of absorption for removal of light oil or gasoline from the gas; in increasing the efficiency of removal of the light oil from the absorption oil; in reducing the size and expense of heat exchange and other parts of the equipment, and in reducing steam or fuel consumed in the process as well as operating expense through the installation of automatic regulation, etc.

Such equipment has been standardized throughout and the definite rating of each piece of apparatus is known for service under usual conditions. The installation of this equipment at any point, therefore, is made more simple and each installation being a new and separate design job is past history.

For a time improvements in absorption towers consisted of the installation of different kinds of filling material of large surface in order to give more intimate contact between the gas and oil, together with means for distributing and redistributing the oil over this surface. At the same time, mechanically operated absorbers were tried out in different fields. There will probably be differences of opinion in different field points as to the results being obtained, but it may generally be stated that the more efficient installations are now developing toward the installation of various types of bubble towers as absorbers, this designation being used

to include both perforated plate and nozzle and bell cap type of bubbling equipment. The nozzle area, periphery of cap, seal, the capacity of run-backs, the distance between plates and counter-flow designs are being so made that reasonably high capacity is being secured for a given tower diameter for this type of work. The gasoline recovery industry did not generally use bubble type stripping stills until recently. These are now pretty generally adopted of improved design and, with the higher temperatures of preheat which have been adopted in the last few years, are stripping their oil extremely clean. Bubble fractionating towers are also being used to make clean separation between the absorber oil and the light oil produced.

portable units by different manufacturers are illustrated in Figures 2 and 3. It would seem that, having such small portable compact and almost automatically operated units available, the size of the city gas plant in which light oil can be economically recovered has been reduced and that many gas plants of medium capacity have been potentially added to the available producers of toluol. It is quite probable that the light oil from such plants should be shipped to some central refining plant for economy.

The solid absorbent processes may prove of some value in future recovery systems. The charcoal system apparently has been developed further than that of the silica gel in commercial installations. Its use, however, in stripping of

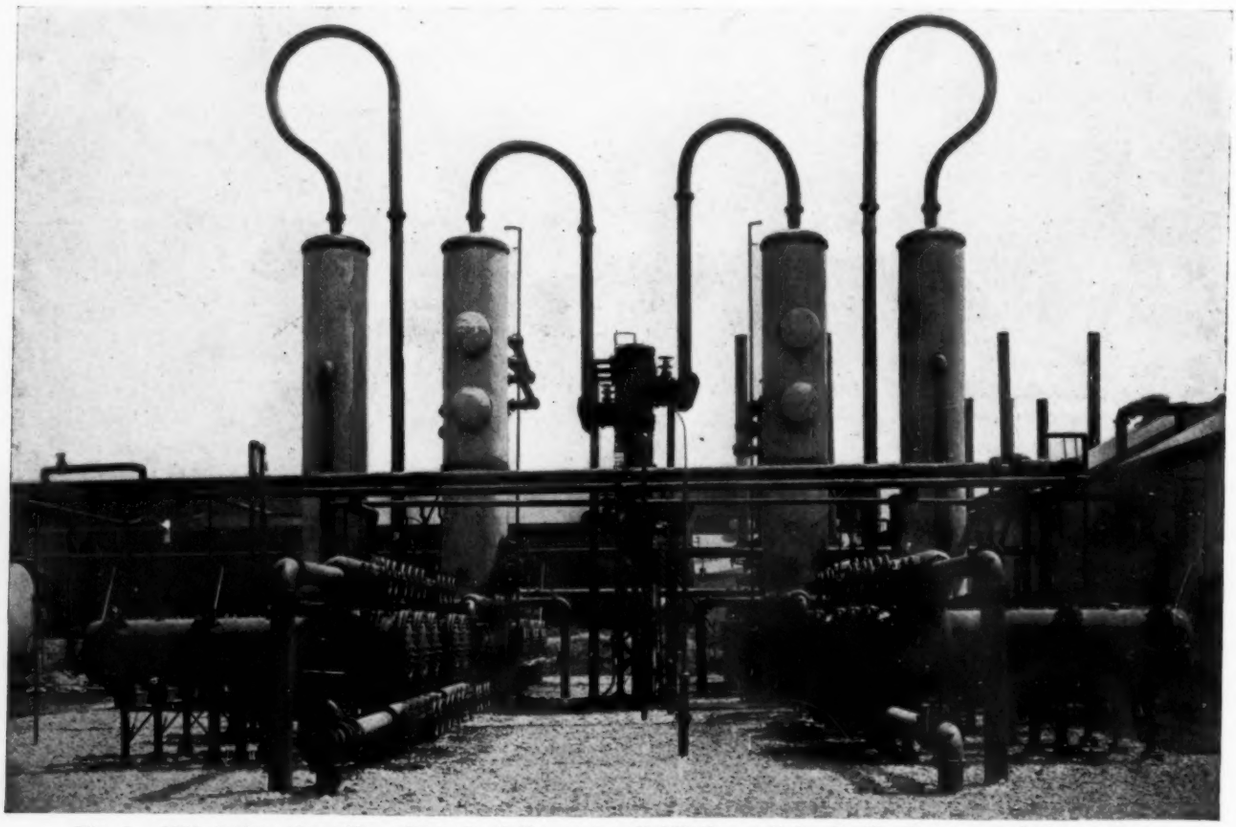


Fig. 1. 1926 design absorption plant circulation and redistillation unit by Pacific Coast manufacturer (one of the largest capacity in the world).

Figure No. 1 illustrates one of the highest capacity distillation units in existence for the recovery of gasoline from natural gas. This was manufactured by a Pacific Coast company, which is shipping such plants and equipment not only throughout this country but all over the world. The absorption towers in this cut are obscured by the distillation units. It is to be particularly noted how compact these units are, how everything is convenient for installation, replacement, or salvage. This illustration shows distillation units in duplicate of a total capacity of 1,000,000 gallons circulation rate of absorber oil per day, and 90,000 gallons of gasoline or light oil produced per day.

Several of the Pacific Coast manufacturers have also developed complete portable plants. These are assembled, even including all inter-equipment piping in the factory, mounted on structural steel bed plates, and shipped complete on trucks or flat cars ready for connecting up to the steam, gas and water lines, and to tankage. Two of such

coke oven or city gas commercially will, to the writer's mind, be dependent on the completeness of tar separation from the gas prior to passing through the charcoal or silica gel absorbers. Some difficulties have been experienced in its operation on natural gas due to incompleteness of separation of petroleum absorbent oils in the gas, requiring expensive re-activation of the solid absorbent material. It would be expected that tarry materials from manufactured gas would present greater difficulties than with petroleum oils. It is believed that the tar elimination should be very much more complete than is necessary to protect the usual purifying material in such manufactured gas plants. Undoubtedly improvements in tar extraction will be made in the future covering this condition.

Special Cracking to Produce Toluene

It should be considered that all sources of toluene in this country are in reality sources producing this material by

cracking, which may be used in the general term meaning the raising of materials to sufficient temperature to break up the chemical structure to produce different materials. This is true both in the carbonization of coal, in the production of carbureted water gas, or of oil gas. None of these cracking systems, however, can be considered of very high efficiency solely for the production of toluene, as these processes are operated primarily for another purpose, although their economic significance in the furnishing of a toluene supply as a by-product incidental to their major operation is not to be minimized.

When, however, the quantity of toluene required or the demand exceeds the economic or possible production from such city gas sources, then special means must be looked into in order to provide the necessary total supply. This was the condition apparent in the recent emergency and many systems for the direct special production of toluene from oil by cracking were studied and tried, with many disappointments and failures in the production of the proper characteristics of the finished product. The continuation of these investigations and trials with extensive research and development work finally, however, led to large scale commercial operation and production of finished toluene of the proper specifications on the Pacific Coast.

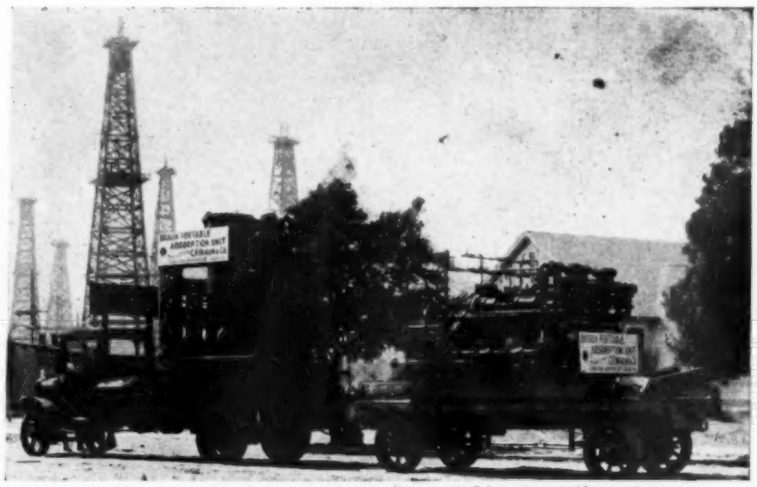


Fig. 2. Complete factory built portable absorption plant—Pacific Coast manufacturer.

The difficulties in the development of processes for this type of cracking are many. The most important difficulty to be overcome is that the finished material must be a pure one and not have oils of other hydrocarbon series, such as paraffins or napthenes, in it. The unsaturated or olefin series of hydrocarbon of boiling point similar to that of toluene is readily removed from the toluene by the extraction with sulphuric acid. However, as the similar boiling oils in the paraffin and napthene series are more stable than the toluene itself to the action of sulphuric acid, such a means of separation is impossible.

Although it was understood that high paraffin toluene was being nitrated abroad by separation after a partial nitration, it was apparent that American nitrators would not consider this possibility and demanded a type of toluene which could be handled for full nitration. This required a toluene having a content of less than half of one per cent. of such paraffin or other oils.

This difficulty of meeting the proper paraffin content not only existed in producing toluene by direct special cracking, but also was a point continually before the producer of toluol from gas plant operations. The proper control was given in these operations usually by an increase in temperature or uniformity of gas heat treatments, even though the temperatures necessary might be somewhat higher than that required for most efficient operation both from a gas production standpoint and a toluene quantity production standpoint.

In the special cracking for toluene production this paraffin limitation indicated the necessity of very high temperatures of cracking. The cracking of a petroleum oil, even at comparatively low temperatures as in the production of cracked gasoline, results in the formation of free carbon. The handling of this free carbon naturally accumulating during such cracking has been the principal source of trouble in even the low temperature cracking for gasoline manufacture. It was found when the temperatures were raised to such an extent as to produce a toluene sufficiently pure in paraffin oils that the amount of carbon produced was extreme. At the same time it was found that such high temperatures used to break down the praffin oils decomposed much of the toluene itself, resulting in an increase in benzol, carbon and gas.

It was found that cracking under pressure resulted in lower total losses, including gas loss, than at low pressures such as existing in the checker brick stoves used in the manufacture of carbureted water gas. The final development, therefore, took the form of tubular heaters for heating the oil to cracking temperature, special containers for the accumulation and removal of the separated carbon developed and designed for minimum operating difficulties, and the condensing of the light oil produced, separating it from fixed gas. Extremely close temperature regulation by automatic means was found to be one of the greatest aids in securing maximum yield and continuity of operation. The proper retreatment by heat of toluol first produced containing paraffin oils was found to give sufficient control over the paraffin content of the finished material. The separation and subsequent cracking of xylol and solvent napthas produced gave a material increase in toluene yield.

This process of cracking, as finally developed and operated, gave a yield of toluene of approximately 5 per cent. of the original petroleum oil used when the charging stock consisted of a paraffin base petroleum as against the yield in carbureted water gas manufacture of approximately 2½ per cent. of the oil so cracked, and in the case of oil gas manufactured of approximately .05 per cent. of the oil used.

The cracking of petroleum oils for the purpose of producing gasoline from heavier petroleum oils has been developed during the last 7 or 8 years to an even greater extent than has the absorption process for recovery of gasoline from natural gas. These developments, while not di-

rectly applicable to cracking for production of toluene, will undoubtedly be helpful in pointing out new structural materials, etc., in improved design of equipment for cracking toluene. They are not directly applicable, as it must be considered that while the temperatures necessary for cracking to toluene may not be but 200° or 300° F. higher than that for cracking to gasoline, yet the physical strength of steel materials between these two temperatures and the activity by oxidation of such steel makes the two problems vastly different.

While the percentage of toluene finally recovered by direct cracking is in larger percentage than that recovered by cracking a petroleum oil in the manufacture of carbureted water gas, yet this does not necessarily mean that due to the greater efficiency the cost will be less. In the case of the carbureted water gas, where this is supplied to a city the net cost of raw materials per gallon of toluene may be low as the major products from the oil can be marketed in their usual market, which was the major product of the use of the oil. In the case of cracking oil for the express purpose of making toluene, there will probably be no market for the considerable gas produced other than fuel of low credit value.

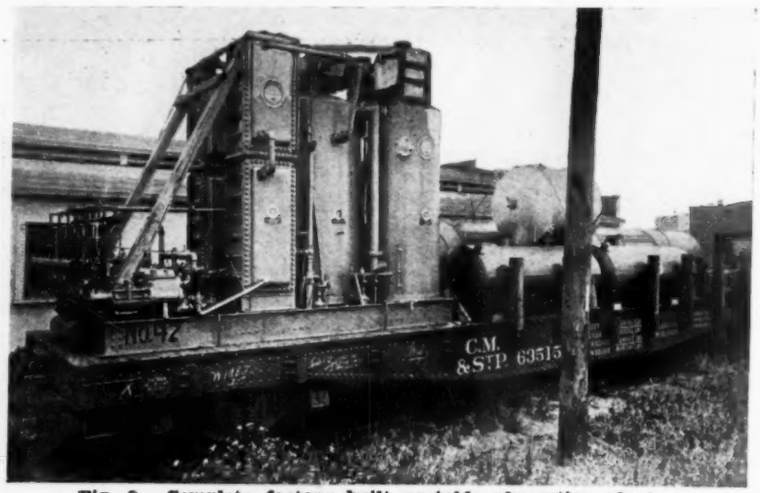


Fig. 3. Complete factory built portable absorption plant—Another Pacific Coast manufacturer.

Selection of Oil for Cracking

Experimental work disclosed that while a normal paraffin base petroleum of a kerosene or light gas oil boiling range could be made to yield approximately 5 per cent. of toluene, yet the same process would produce 30 per cent. of toluene from a strictly aromatic oil such as solvent naptha or xylol. This corresponding increase in production was also found to result from petroleum oils containing aromatic oils naturally, although such aromatics do not exist as toluene in the original petroleum distillate. The oils from California were found to contain an appreciable quantity of such aromatic oils and the yields secured by cracking distillates from this region resulted in an increase to 6 per cent. of toluene from the original oil. This gives the Pacific Coast a certain economic advantage in the direct cracking of natural petroleum for this purpose.

It must be considered that the heavy cracking necessary to produce this material results in large losses and the possibility of securing such a large yield from an aromatic oil points out that all efforts should be extended to collect and crack all xylol and solvent naptha possible, even diverting these products from other uses before cracking too extensively into virgin petroleum oils.

In the cracking of petroleum oils for the production of gasoline a number of the processes produce distillate which is sometimes called cycle stock, which has a boiling range of about the original gas oil, but now contains some aromatic hydrocarbons. A thorough investigation of the potential possibilities of heavily cracking such partially cracked cycle stock might lead to economy in the production of toluene.

Separation of Paraffin and Aromatic Hydrocarbon Oils

A number of installations have been made in the last few years on the Pacific Coast of the liquid SO_2 process for treating of certain petroleum oils by selective solubility. This process is known as the Edeleanu process and is the invention of Dr. L. Edeleanu of Roumania. The process operates by mixing liquid sulphur dioxide in the cold and under some pressure with the oil to be treated. After agitation the oil separates into two layers, the upper one consisting of liquid SO_2 and praffin series oils predominating, and the lower layer consisting of liquid SO_2 and aromatic and unsaturated oils predominating. The lower layer is drawn off thus separating it from the upper layer and the liquid SO_2 eliminated by expansion from each of the two products separately and compressed to the liquid form for further use. The two oils can then be washed and further treated if necessary.

It has been suggested that the aromatic oils so separated in normal refining may be valuable stock for cracking to toluol. Should the necessitiy for large production of toluene arise, this possibility of concentrating aromatic oils both from petroleum in which such oils naturally occur and also in partially cracked oils from gasoline cracking plants should not be overlooked.

This process of separating aromatic from paraffin hydrocarbons might profitably also be investigated for the removal of paraffin oils from finished toluene. If such separation were worked out sufficiently so that high paraffin toluene could be delivered as specification toluene without further heat treatment, it is highly probable that cracking temperatures could be reduced and higher yields of toluene secured with a corresponding lower production of benzol.

Rifle and Ammunition Board Appointed

A board to test and determine types of arms and ammunition to be used in the National and International Matches, 1927, has been appointed. Members of the board are: Brig. Gen. C. L'H. Ruggles, Ord. Dept., U. S. A.; Col. A. J. Macnab, Jr., Inf.; Lieut. Col. G. C. Shaw, Inf.; Comdr. E. E. Wilson, U. S. N.; Lieut. Col. Townsend Whelen, Ord. Dept.; Lieut. Col. F. M. Waterbury, Ord. Res.; Maj. R. S. Keyser, U. S. M. C.; Maj. C. W. Baird, C. A. C.; Maj. W. L. Clay, Ord. Dept.; Maj. Herbert O'Leary, Ord. Dept.; Maj. L. W. T. Waller, M. C. Res.; Maj. F. W. Parker, Jr., Ord. Res.; Capt. J. L. Hatcher, Ord. Dept.; and Maj. K. K. V. Casey.

The San Leandro plant and main offices of the Caterpillar Tractor Co.

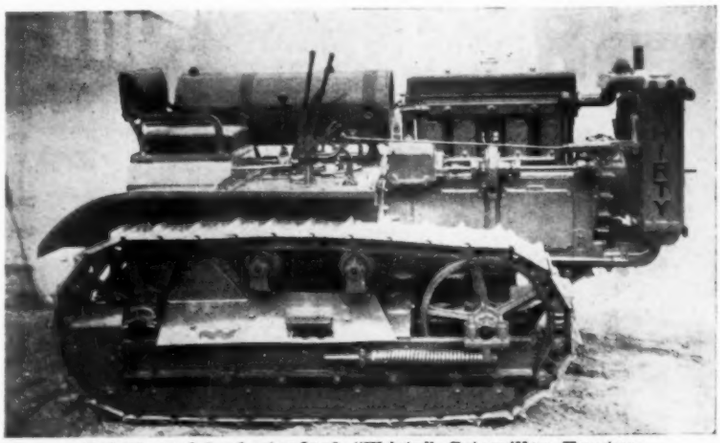
Caterpillar Tractors

Maj. W. A. Capron, Ord. Dept., U. S. A.

THE Caterpillar Tractor Company, which during May, 1925, acquired both the C. L. Best Tractor and the Holt Manufacturing Companies, has its executive offices and main plant at San Leandro, Calif., with a factory branch in Peoria, Ill. This organization comprises approximately 55 acres, employs about two thousand men (including a night shift at both plants) and produces daily 141 tons of finished product at a sale value of more than $85,000.00.

It may be of interest to those who were familiar with the former Holt Company's plant at Stockton, Calif., to know that that installation now comprises The Western Harvester Company, which, under the direction of the Caterpillar Tractor Company, is successfully manufacturing an improved combined harvester on a much greater production scale than ever before.

The Peoria plant, producing the "Sixty" or Model A, the 5-Ton and the 2-Ton types of Caterpillar, is equipped in a similar manner to the San Leandro plant which produces the "Sixty" and the "Thirty" or Model S, and though neither factory has its own forging or foundry facilities, both perform all operations on the raw material, rough castings and forgings entering into the finished product. The following description is devoted entirely to the San Leandro plant, at which place there is stationed an officer of the Ordnance Department, but the facilities, processes, and production methods set forth are generally applicable to the Eastern branch in Peoria.



Latest model of standard "Thirty" Caterpillar Tractor, excellent for artillery use.

The San Leandro plant, occupying about fifteen acres, is ideally located respecting land and sea transportation because the shops are bordered on two sides by the Western Pacific and the Southern Pacific railroads, respectively, and are within one hour's run of the Oakland and San Francisco waterfronts.

The buildings are, for the most part, of corrigated G. I. sheeting, which is excellent construction for this locality because of the mild climate throughout the year. Generous window and ventilating capacity is provided and all flooring, except that of the heat treat department, which is concrete, is of creosoted wood blocks, tarred and laid on concrete. A new one-story brick office building affording approximately 40,000 square feet of floor space with a fireproof vault of 5,000 additional square feet, is well under way. There is also a new warehouse of 20,000 square feet under construction.

Essentially the installation consists of the office, the production machine shop, the track, heat treat and service departments, the assembly lines, the smith and carpenter shops, the engineering department, and the engineering research, chemical, and metallographical laboratories.

In the production of tractors this factory handles all operations from the initial anneal or normalizing, through the machining and subsequent heat

A battery of Gleason bevel gear generators.

treatment, to the final assembly including all of the 3,417 separately numbered parts constituting a tractor. The only exception other than standard hardware, carburetors, magnetos, etc., is the camshaft which is purchased complete. The daily production is three "Sixtys" and four "Thirtys."

Electric power for plant operation is supplied at 11,000 volts, 60 cycles, 3 phase by the Pacific Gas and Electric Company which maintains a bank of three 500 k. v. a. transformers stepping down the line voltage to 4,400 for supplying a group of transformers owned and operated by Caterpillar Tractor Company. This group consists of two banks of three 200 k. v. a. and one bank of three 75 k. v. a. transformers, the two unit banks distributing to the plant at 110 and 220 volts, 3 phase for lighting and motor use and the one bank unit at 110 volts for heat treat furnaces. The motor capacity (459 motors) is 2447 h. p. and the monthly power consumption 227,200 k. w. h. with a peak load of 873 k. w.

The air compressor unit has a total maximum capacity of 2,911 cu. ft. free air per minute and maximum consumption being 1,050 and the average 721 cu. ft. The shop pressure is maintained at 85 lbs. with automatic alarm bells set for 75 and 70 depending upon the location in the works. There are three 2-stage and one single-stage Ingersol Rand compressers. As a safety precaution the cooling system of each compresser is thermostatically connected with the no-voltage release of the driving motor line.

Steam for heating, processing, and cleaning and refining the cutting and quenching oils is supplied at 50 lbs. gage by three 100 h. p. horizontal boilers. With reference to cutting oils, the plant maintains a unit consisting of a hand pump and tank of 150 gallons capacity which, conveyed by truck, procures crank case drainings from local garages to be used for cutting purposes. These drainings, amounting to 450 gallons each week, after dehydration and cleaning make an excellent cutting oil at very low cost.

A 10-inch, 327 feet well on the company's property, with a Byron and Jackson eight-stage turbine and 10,000 gallon tank supplies water for all purposes at a head of sixty feet. For emergency use a 4-inch meter is connected with the city main.

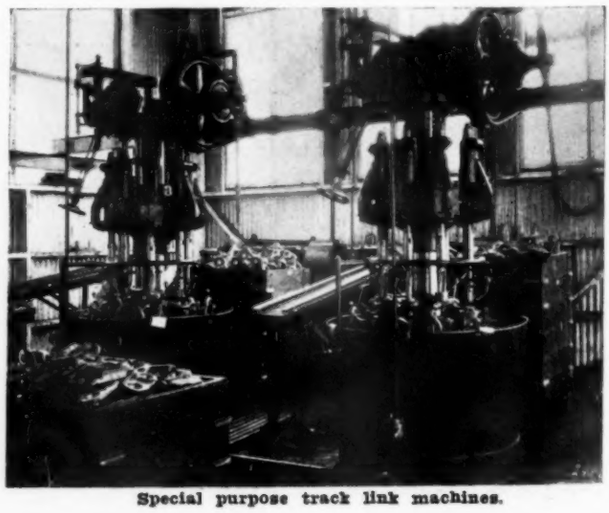
Plant fire protection in all buildings is assured by an over-head sprinkler system whose primary water supply is two 50,000 gallon tanks with a 127 feet head. The secondary supply is an 8-inch direct connection with city water and engine connections through twin plugs allowing city engines to pump into the system. The installation is tested each month. In addition there are provided city fire alarm boxes, direct connection with the A. T. D. watchman service, and 40-gallon, wheeled, chemical extinguishers and 2½-gallon hand extinguishers throughout the plant.

Internal shop transportation, other than crane service, is carried on by means of the Elwell Parker elevating platform, low wheel, electric truck system, for which more than 3,000 trays are maintained. The system is augmented in certain cases by four-wheel electric trucks of several different types, and by the hand-operated Cowan Hydraulic Transveyor. Over-head crane service is available in part of the shop and in the shipping and service department, while tractors are used for car shifting in the yards. Outside local transportation is handled by Buick ¾-ton, Packard 3- and 5-ton, and Fageol 5-ton trucks.

The shop personnel, including a night shift for five nights a week, comprises more than eight hundred men, most of whom have been with the company over a long period of years. Vacancies in the higher shop positions are filled from the ranks of the operatives which fact produces an ambitious and enthusiastic organization. The 8-hour day starts at 8 o'clock, making a 44-hour week. Group life and health insurance is in effect generally throughout the plants of the company.

An apprentice school for assuring an adequate supply of highly trained operatives to meet the future needs of the company, is maintained in conjunction with the production plant. This system of training, conforming to the most recent industrial practice, in securing specialized young men, has been in operation about two years, contemplates, with six months' probation, a four years' course, and is officially recognized by the State Department of Trade and Industrial Education as meeting the requirements of the Smith-Hughes act. The mental requirement for admission is a grammar school education, and the course has proved so popular that approximately 500 applications for the course have been received from over the State.

The medical staff on the plant consists of a trained nurse



Special purpose track link machines.

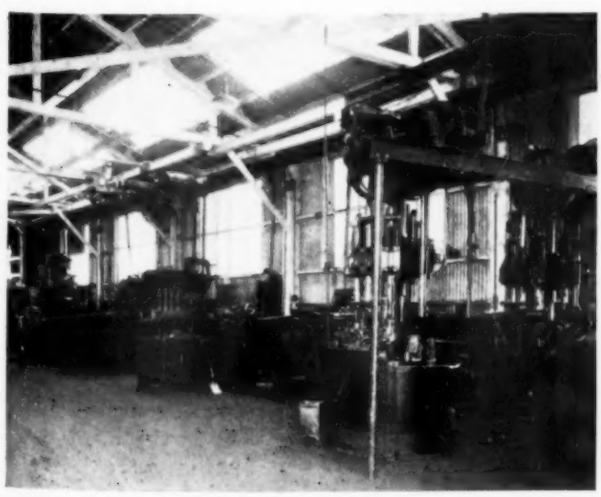
who is continually on duty during working hours and an attending surgeon who is present for several hours each day. Irregular, though frequent, inspections of the works insures the maintenance of sanitary conditions throughout.

The engineering department, with a force of twenty-two persons, is divided into two sections, one on tool design (jigs, fixtures, gages, and machine tools) and one on regular engineering and tractor design. The excellent feature here is that both sections are organized under one executive and technical head. The designer and the production man meet with friendly equality in this department which assures that standard design is well adapted to quantity production methods.

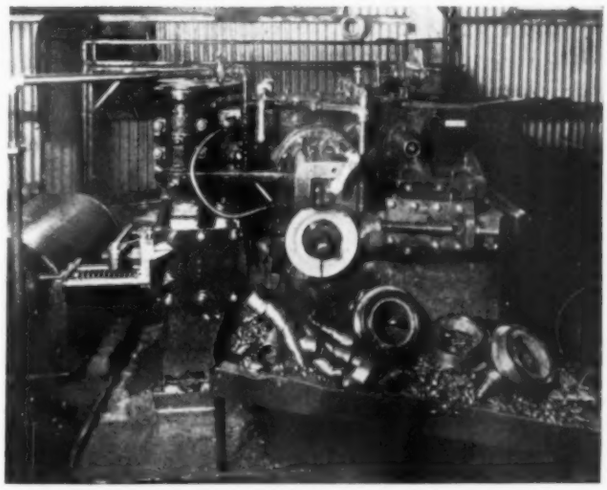
The planning department, consisting of but eight persons, has effected an efficient system throughout the plant. The unit time on operations is found from actual time studies based upon machine burden and work routing, the Hollerith tabulating system being used for checking men's production of percentage of task earned against time on operations as set by time studies. The percentage of task earned as found by the planning room is entered on each man's card by the personnel department for checking purposes. The day and night shifts are informed of their comparative production by color scheme charts posted in each department. Continual retiming, and improvement in operation methods and frequent analyses of various groups and departments, make for constant improvement in manufacture. It is such methods, that, in part, made it possible recently to reduce the combined selling price of the "Sixty," "Thirty" and the 2-Ton by one thousand dollars.

The stock of raw material maintained on hand is that necessary for one month's production, with two weeks' supply in the shop, two weeks' supply on the assembly floor, and a month's supply of raw material in transit from the manufacturer. Gray and malleable iron, carbon steel, brass, aluminum, and bronze castings are procured in and around the San Francisco Bay district with certain small forgings coming from the southern part of the state. The sources of supply for hot and cold rolled carbon and alloy steel, cold drawn seamless steel tubing, and forgings, including the 340-lb. "Sixty" crank shaft, are located as far East as Cleveland, Ohio.

Inspection of incoming material, in the case of forgings,



The track link production line.



Special purpose machine for handling track roller rims.

for example, involves the response to a standard heat treatment of a fixed percentage of pieces of each different heat in the shipment. If abnormal results obtain, a metallographic and chemical analysis is made, together with a physical test, the outcome of which is the basis for a special heat treat or the final rejection of that particular heat in the shipment. Springs receive a functional test where partial failure is followed up in metallographic and chemical laboratories. All bar stock is tested by the heat treat department, and in addition, special size bar stock for parts such as the accessory and oil pump shafts, sprocket hub studs, track spools and pins, is given a 100 per cent. inspection as to size. The cam shaft and all antifriction bearings are given a 100 per cent. hardness test. Castings are 100 per cent. visually inspected and a certain percentage of test lugs chemically analyzed for comparison with the foundry analysis. Inspection during manufacture includes the set up in the machine, the inspector's signature appearing on all job cards stamped "Set Up," the finished piece by gages on hand at the machine, and the Brinell, Scleroscope, and Rockwell tester for hardness during and after heat treat, while in the case of transmission and final drive gears a gaging on centers before and after heat treat. Cylinders and cylinder heads before grinding, and radiators after assembly are tested under hydrostatic pressure. Inspection closes with a detailed checking of each tractor during its two-hour run on the test floor and a final general survey while loading or preparing for shipment at the plant.

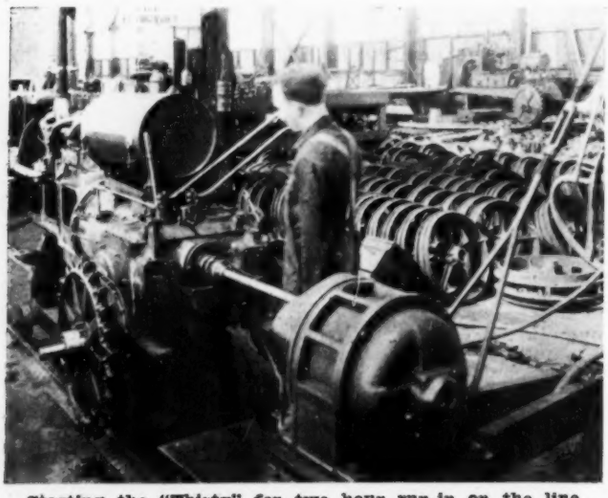
The production machine shop, of approximately 45,000 square feet, was originally laid out on a grouping basis by machine classification but is steadily undergoing rearrangement by machining operation to produce straight line production, the rate of rearrangement being governed by production increments and the necessity of preventing machine idleness. Straight line production groups now in operation are those handling the pistons, the cylinders, the crank shafts, and the transmission gears for both the "Sixty" and "Thirty."

The crank and transmission case department, which after several contemplated internal routing changes, will be an excellent example of straight line production, receives the rough cast crank cases and transmission cases for both

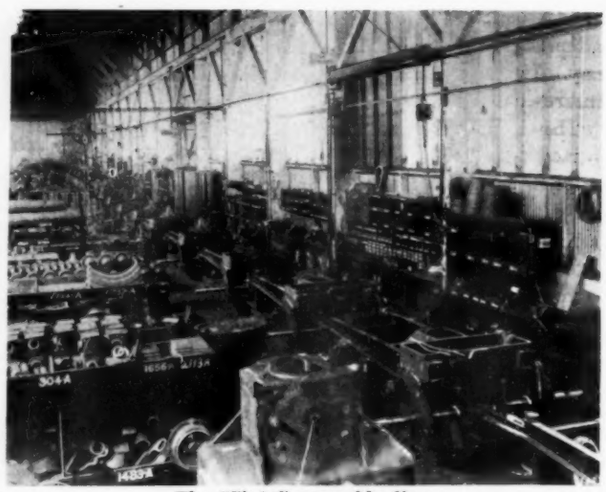
sizes of tractor and discharges them finished to the respective assembly lines. This department contains, besides the several special laying-out fixtures, five special boring mills and one special drill press designed on the works, as well as standard planers, side and head millers, boring mills, and drill presses. The special boring mills produce perfect alignment of shaft bearing seats while the jig drilling, used throughout, assures uniform interchangeability and accurate fitting. The model "A" transmission case of 1,583 pounds and the crank case of 675 pounds receive, respectively, 17 operations on 9 tools, and 10 operations on 5 tools, while these members for the model "S," 685 and 523 pounds, receive, respectively, 15 operations on 9 and 13 operations on 8 tools. The model "S" transmission top cover is also completely machined in this department.

The sheet metal shop manufactures the fuel tank, fuel lines, pressure grease gun tank, all shims, control and ignition wire sets, radiator shields, fan shrouds, etc., and in addition assembles the radiator and the thermoid lining to the steering clutch brake. Radiator tubes as purchased, are assembled to the upper and lower headers by hand. The operation consists of corking with asbestos cord packing, coating with a coal tar product, and setting up a threaded bronze packing nut. The construction is such as to afford maximum thermal expansion, mechanical weave, and ready individual replacement. The finished radiator, as a test, is subjected to a hydrostatic pressure of 25 pounds for one hour.

The track department, a building of 10,000 feet floor space, including 1,200 feet devoted to the engineering research laboratory, is a self-contained unit, performing all machining, heat treat, and assembly operations, except annealing and carburizing, on the complete track and the track rollers. This department is, perhaps, the most excellent example of straight line production in the plant. The forged steel links (weight ten pounds, Model "A") previously annealed in the heat treat department, enter at one end of the shop where spool and pin holes, rights and lefts, are rough and finished drilled and reamed on a special purpose machine, then by gravity roller conveyors for rights and lefts, to a continuous rotary miller where the rail flats, rights and lefts together are machined, by conveyors to the successive operations of spotting flats for shoe bolt nuts, slotting cotter way in pin end, counter-

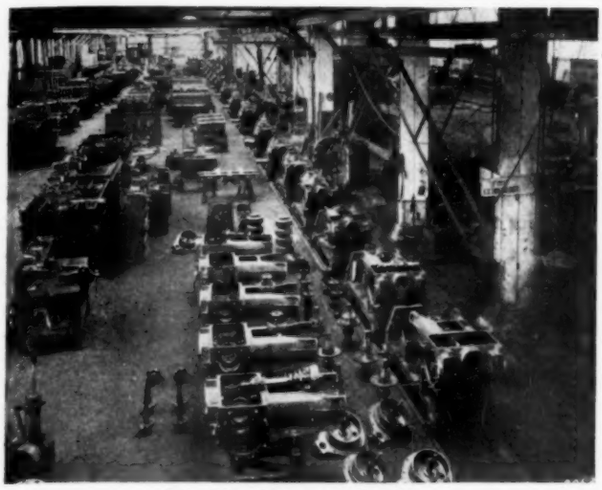


Starting the "Thirty" for two hour run-in on the line. (The electric motor is for starting only).



The "Sixty" assembly line.

boring pin holes and boring shoe bolt holes. At this point is a rotary, automatic control and recorded electric furnace for heating the links to proper quenching temperature (approximately 1,500° F). The quenching fixture and water stream are such as to give a selective quench in that the roller face of the link is hard while the shoe face is softer and tough. The link is placed in the fixture and a foot pedal releases the automatic quench-timing mechanism which starts and stops the water stream at a predetermined interval. As a check, a certain percentage of each forging heat is brinelled on both faces. The quenched link, removed from the fixture, is automatically fed through an automatic control and recorded electric draw furnace, after which assembly (132 links per track) with the case hard spools and pins is effected in an 80-ton hydraulic press. A small portable, hand-operated, 75-ton hydraulic press is issued to tractor dealers for replacing pins and spools in the field. After the solid cotter pins are up set, the forged shoes with nickel steel bolts and nuts are loosely assembled by hand, the final set up being made with a motor-driven socket wrench, which through the medium of a pneumatic friction clutch, clips at a predetermined tortional load and is released entirely by the operator's foot for passing from bolt to bolt. This wrench effects a uniform set up of the shoes and, in addition, gives each bolt a physical test (264 bolts per track, Model "A"). It is interesting to note that the first three machine tools in this line, the two furnaces, the special wrench, and the assembly press were designed and built on the works. Briefly, the track pins and spools after cutting to length from solid bar and seamless steel tubing stock in Cleveland automatics are, respectively, drilled for pin, and broached and turned to size, etc., then carburized in the heat treat (18 to 20 hours including 6 to 8 hours at heat) with samples of each heat checked for depth of case by hand microscope to a tolerance of .2-mm., and returned to the track department for heating in an automatically controlled and recorded rotary electric furnace for water quench at a fixed head. Samples of each heat are given a 100 per cent. scleroscope test. Track rollers consist of a cast-iron hub with a shrunk-on, forged, carbon steel rim. The hub, after six machining operations, is placed on a special fixture where the rim is selectively quenched and shrunk-on after machining in an automatic tool which, designed and built in the plant, feeds a forming tool di-



The "Thirty" assembly line.

rectly into the rough forging and removing 6½ pounds of stock per minute, forms and finishes the flange and tire face in three minutes. For checking purposes, 20 per cent. of all rims are brinelled to the different specifications for flange and roller face. In shrinking on the rim, that member is heated in a rotary electric furnace, the first and second stages being automatically controlled while the third stage is both controlled and recorded. Both the operation of the fixture and duration of the quench are automatic, the operator simply places rim on hub and kicks a foot pedal. The controlling mechanism, indentical with that for timing the link quench, consists, essentially, of a small motor, a gear set, a syphon connected to the shop air, a graduated time disc with return springs, and the appropriate contacts for solenoid-operated air valves. The quenching water is maintained at constant temperature by thermostatic control of a cold water supply. A furnace time card system indentical to that in operation in the heat treat department is maintained in this shop. The hub which is slightly constricted by the rim shrink, is broached in the track assembly press. The completed track is transferred by mono rail to its assembly point on the erecting floor, and the rollers are delivered to a sub-assembly on the erecting floor where the antifriction bearings, cork seals, dust collar, shafts, etc., are installed prior to assembly in the swing frame.

The heat treat department, besides special experimental and inspection operations, handles 576 separate pieces in each tractor, exclusive of washers, cotter pins, etc. These consist of 17 cyanided, 61 annealed, 284 case hardened (carburized and hardened), and 214 hardened (annealed and hardened). The furnaces, except the "Humps," "Homo" draw, tool room, etc., are oil fired. The oil, California crude (19 Baumè), supplied from storage at 85 pounds, enters the continuous circulation system at 15 pounds and is preheated to 150° F. Air for the burners is supplied at fifteen ounces by G. E. blowers. Of the oil-fired furnaces, two rotaries for heat treat and one for carburizing are automatically controlled and recorded, the remainder, 8 carburizing, 3 anneal, 4 reheat, and 1 special for sprockets are indicated by potentiometer with 2 couples per furnace. The entire pyrometer system is completely checked every two weeks. The oil-fired furnaces, with four exceptions, are of the heavy, semi-muffled, under-fired, type.

The Hump furnaces, for the transmission and final drive gears, need no explanation. The Rockwell Dilatometer installation attached to one of the gear-treating furnaces is probably the first of this type of equipment on the West Coast, and its results are being observed with great interest. This system, operation of which is based upon the volumetric changes of the charge during the heating cycle, makes for very accurate treatment, in that the instant the proper time for quenching is reached, indication is automatically given by an electric alarm system. For heating and selectively quenching the 240-pound, cast steel, track sprocket, there is provided (designed and built on the works) a special oil-fired furnace with hydraulically controlled hearth operating in conjunction with a 30-ton press which prevents distortion during the water quench. A Gleason press is used in oil quenching the main bevel gear (alloy steel, 17.2 pitch diameter with 43 teeth). Except in one instance (the track sprocket) the undesirable oil and salt draw pots are replaced by the "Homo" electric draw furnace, which, in this case, is special, as a draw of 1,200° F. is attainable. This installation assures a rapid, accurately controlled, uniform and clean draw. One size carburizing box is used, with standard packing arrangement for each of the different parts charged. The carburizer, consisting of charred, carbonate-treated peach pits is manufactured on the West Coast. It is distinguished by its low shrinkage, minimum fines, and low weight per volume, while its carburizing characteristics compare favorably with those of the more well known compounds, though its cost is considerably less. For control purposes each charged box contains a standard S. A. E. steel sample and a sample of the particular stock in the charge. These samples are compared for depth of case by hand microscope, a tolerance of .2-mm. being allowed. All carburized parts are reheated to a standard temperature before quenching. A record is filed showing the part, the box, the furnace, the box location in the furnace, and the result of comparison of the control samples. In order to maintain a complete history of transmission and final drive gears, all of which are alloy steel, these members are each stamped with an individual heat treat serial number, and a record showing time periods, temperatures, results of hardness test, etc., is filed against each number. The same card system for cost accounting purposes, etc., as used in the machine and other

The test rack, for final run-in and inspection purposes.

shops, is in effect in the heat treat (omitting unit time on operations) with the addition of furnace cards. These cards, a set for each furnace, red, yellow, and blue, termed, respectively, "Idle furnace," "Fuel on" and "No Fuel," are clock punched at start and stop of each indicated condition, with a separate set of yellows and blues made up for each different part (not piece) charged in that particular furnace at that particular time in the same manner that the operator simultaneously runs his own "White" card. All cards show furnace number and date; white, yellow, and blue cards show order, part, and operation numbers and the number of pieces in the charge. The usual entries of elapsed time, rate, total amount, etc., and the punching of these data in the appropriate lines and columns with a key punch for use with the Hollerith tabulator, is carried out in the office. The necessary sand blast, metallographic and chemical laboratories and physical test equipment is operated in conjunction with the heat treat.

The gear and clutch assembly assembles all steering clutches, from riveting the 64 raybestos liners on the steel discs, to the entire steering clutch unit weighing 862 pounds and containing 2 clutches (each with inner and outer drum, and 32 driving and 32 driven discs), sleeves, main bevel gear, and antifriction thrust and taper roller bearings. The Model "S" outer drum is not assembled here but later with the cannon housing on the line. Among other assemblies handled here are the "Sixty" fan, gears to lower transmission shaft, fly-wheel adjusting collar and shifter, various roller bearings pressed on, and the final drive pinion with the member connecting it to the driven drum of the steering clutch. This particular assembly, a two-key taper, is handled in the greatest detail by a special process, with such results that, upon test, a minimum of 18 tons is necessary to press out the pinion shaft from the hub, and never has this point caused trouble in the field. This department also operates the first portion of the "Thirty" assembly line, handling the installation of transmission, gear and clutch, the controls and final drive, or briefly, up to the point where the crank case enters the assembly.

The "Thirty" snow "job" with cab and lighting system.

Paralleling the "Sixty" assembly is the line for the "Sixty" engine. This line is fifty yards in length, contains five stations with eleven men on the track and two on sub-assemblies. The crank case, forming the basis of the assembly is first cleaned, gaged at certain points, tested for leaks, cored holes plugged, the inside coated with a special shellac, and inspected. All bearings with shims complete are assembled and the case set up on a special table for line-boring the bearings with air-driven tools, one for roughing and one finishing. The connecting rod big end bearing is bored in a similar manner, the rods fitted to a particular crank shaft by scraping (very little scraping is necessary), and each stamped with its engine number and position number on the shaft. The main bearings, by a small amount of scraping, are fitted to the crank shaft. The assembly, from this point on, progresses as follows: Oil lines, shaft, pump, and pan; crank shaft, fly-wheel, connecting rods and pistons, cylinders, cylinder heads complete with valve and springs, manifolds, etc., and lay out fly-wheel for timing; cam shaft, oil and water pumps; magneto installed and timed, and finally after timing the completed engine is delivered to its point of assembly on a "Sixty" line. This assembly requires 16 man hours, the engine is not run in and is balanced statically but not dynamically.

The north-east housed portion of the production plant consists of a bay 50 by 755 feet long with over-head crane service which is continuous outside the building, across a city street, and through the length of the service department. This bay is occupied by the crank and transmission case department, of 167 feet, the main erecting floor of 394 feet, and the testing floor of 194 feet. The "Sixty" assembly line, extending throughout the erecting floor, is composed of seven stations and employs fifteen men on the track with one man on sub-assemblies. The beginning of the line adjoins the transmission case department which is an ideal location because that member forms the basis of a tractor assembly. The transmission case, with both halves of the sprocket shaft assembled, is placed upon a wooden, flanged wheel carriage which conveys the tractor along a track by hand power during the progressive assembly. The several stations, operating on a time study basis, are supplied with a two weeks' stock of parts except in the case of such sub-assemblies as the final drive gear with hub, housing and sprocket, the engine, the roller frame, radiator, etc., which are made up approximately as required. The assembly, requiring 32 man hours, is carried on in the following general order: The main frame (tractor serial number now stamped on), final drive pinion along with its clutch flange and bearings, transmission shafts with gears, main clutch, steering clutch assembly, gear shifter assembly and housing, final drive gear with hub, housing and sprocket, transmis-

sion rear cover and steering clutch control, engine complete, platform, equalizer bar, fuel system, and tank. At this point the motor is started by a fixture, and runs on its own power, driving transmission, final drive and sprocket for a period of two hours. The whole assembly is now placed on the roller frame which has been made ready as a sub-assembly on a low platform. After attachment of the roller frame the whole unit is placed, by over-head crane, on its tracks, which are then connected by the master pins. The seat now being installed, the tractor is complete, except for the top or canopy which is attached after the final run in and inspection.

The "Thirty" assembly line, 106 yards long with eight stations employing 13 men on the track and two on sub-assemblies, is similar in operation to that of the "Sixty" except for differences arising in the case of the steering clutch and bevel gear assembly, the barrel-type crank case replacing the main frame, and the progressive assembly of the engine on and with the tractor. The assembly of this tractor, including its engine, requires 35 man hours.

The "Armored 'Sixty' logger." A good prime mover for heavy mobile artillery.

The completed tractor moves on its own power into the test rack which consists of two lubricated metal floor plates, a stout hitching post or dead man, a pit, and the necessary safety screens. The draw bar is made fast to the post and the tractor run in at the various forward speeds for two hours with its track slipping on the floor plates. During this run an inspector goes over every detail of the mechanism and sets and seals the governor for idle and full load engine speeds (300 and 728 R. P. M., or 650 loaded). Any troubles found are chalked on a bulletin board and the tractor removed from production until correction is made.

Painting is effected by air spray except on inaccessible members which are hand coated before or during assembly. A special tractor paint consisting of three different coats has been developed by the W. P. Fuller Company for "Caterpillar" use.

The service department which is entirely distinct from the production plant, occupies approximately 45,000 square feet, employs 90 men, and contains its own storage, machine shop, and erecting floor. This department manufactures, assembles, and installs all non-production and special equipment, accessories, and attachments such as the logging wheeler, hydraulic pump, stationary drive, winches, and air compressors used upon tractors and, in addition, spare parts for tractors no longer in production. The stock room, operating on a continuous inventory basis, specializes on non-production tractor parts, although a reasonable supply for those of standard manufacture is maintained. There are parts on hand for tractors built 15 years ago. Tractors are prepared for shipment in this department and every probable shipping condition has been standardized with drawings and photographs. These shipping combinations range from a complete tractor slushed for sea transport, packages of minimum bulk without dismantling sub-assemblies or deranging adjustments, to separate packed loads not exceeding 500 pounds and 180 pounds respectively for lightering on African rivers and coolie transport over South American mountains. The final shipping operations are conducted by the plant inspection department which, at this point, terminates its close scrutiny of the tractor.

Based upon the wise policy of the Chief of Ordnance respecting the use of standard commercial tractors for military purposes and his specific recommendations in the premises, the War Department has officially adopted the three sizes of Caterpillar Tractors, the "Sixty," the "Thirty" and the 2-ton. In this connection the question of military emergency requirements (requirements so enormous as to warrant reconsideration) has been most carefully considered by officials of the Caterpillar Tractor Company who, after a detailed preliminary study, have decided upon a definite emergency production plan. The detailing of this plan involves, perhaps, a year's work by production experts of the company, but, in general, the program is such as to assure tractor production on almost any reasonable quantitative time scale with a minimum preparatory period, provided the supply of raw material, labor, power, and other necessities is made available.

There is no need to detail the excellency of the tractors whose production is outlined in the preceding paragraphs; it is sufficient to state that their worth for military purposes, a field demanding the most drastic requirements, is being recognized by seven different nations, exclusive of the United States.

Ground Shock Meter

The device shown in Fig. 34, page 222, November-December, 1926, issue of ARMY ORDNANCE, entitled "An Early Type of Blast Meter," was originally designed by Mr. Homer G. Gibbs, of the Trojan Powder Company, as a ground shock meter and for that purpose the blast in the gun was carefully excluded.

Industrial Preparedness and the California Manufacturers Association

Maj. J. A. Dorst, C. E., U. S. A.

To understand the relation between Industrial Preparedness on the Pacific Coast and the California Manufacturers Association, it is necessary to explain first something of the picture into which the Association fits. Obtaining supplies in time of war is variously known as Mobilization of Materials, War Procurement, Mass Procurement, Industrial Preparedness. The primary object is "Supplies on Time." A related purpose almost as important as the first one, is obtaining these supplies with the minimum disturbance to the economic framework of the country.

OTTO FISCHER
President, California Manufacturers Association.

Planning on this subject is extremely important. Supply is the present controlling factor in plans for mobilization of manpower and, in time of war, it occupies by far the greater part of military energy. During the late war, for every soldier in the Army, there were seventeen people connected with supplies directly or indirectly, and for every soldier on the firing line there were several soldiers behind him getting the necessary matériels forward. As one enlisted man put it: "It's not the fighting but the work that makes war hell."

The present planning has come about through a general realization that many industrial mistakes during the past war can and should be avoided in the future. The Act of June 4, 1920, authorized the War Department to undertake such planning. Accordingly the United States has been divided into fourteen territorial districts, and each of the seven supply branches of that department has representatives throughout the country. Each supply branch is organized along commodity lines. The Ordnance Department is interested in guns and ammunition, the Air Corps in airplanes, the Quartermaster corps in motor transportation, food and clothing, and general construction in the home land, the Corps of Engineers in general construction and materials therefor in the Theatre of Operations, the Signal Corps in communication by telegraph, telephone and wireless, the Medical Corps in medical supplies, and the Chemical Warfare Service in gasmasks and various chemicals. The general war load on the country has been fairly accurately calculated and has been redistributed along branch lines to the various districts.

The problem facing the War Department is how to obtain these supplies in time of war speedily, smoothly, surely and with minimum adjustment on the part of the business life of the country. In its essential outline, the problem is one of proper distribution rather than of increased production—during the first year, one hundred and fifteen million people are asked to provide for the military needs of about 3 per cent. of their number. These 3 per cent. will eat about the same amount of food as before. They will wear, roughly speaking, the same amount of clothing as before, although of different cut and color. However, just as there must be water in the pipes of a water system and something additional in the reservoir, before there can be continuous flow from the spigot, just so must the supply reservoirs be partly filled in addition to the quantity given troops actually in service. Hence, the *average load* imposed upon the country to meet War Department requirements is estimated as about 10 per cent. of normal annual production. In fact, this country has such great resources and is so well organized industrially, that only four general items assume major importance from the production as contrasted with the distribution standpoint, namely, airplanes, guns and ammunition, and perhaps ships.

The 14th War Department Procurement District, comprises Idaho, Nevada and the Pacific Coast States. Each of the seven supply branches has its district representative in San Francisco. While each procurement planning agent is directly responsible to his branch chief, these agents meet monthly to discuss common problems, and by this means have achieved marked cooperation in planning.

From a procurement standpoint, this district is well favored. It has a wide range of products, and is noted for its great reserves of foodstuff of various kinds, of lumber, of oil and oil derivatives. Although even if Utah be considered, the primary steel and iron produced is small with respect to the eastern output, the reason for no greater relative development so far is economic—the potential resources in coal and iron are very large. Moreover, ample power exists, the climate is, in general, mild, the main manufacturing centers—Los Angeles, San Francisco, Portland, Seattle and Tacoma—are served by a transportation system that is very complete, and industry on the coast is well organized. Finally, there is a hardy, homogeneous population of some 6,000,000 people.

The local problem faced by the procurement planning agents at San Francisco is to spread equitably over this territory the quota of the war load assigned them. This quota is constantly undergoing revision, but runs around $500,000,000 for the first year. The total value of manufactured products on this coast in 1924 was about four billion dollars, so that the load is roughly 10 per cent.

Without going into the details of how the War Department representatives establish personal contacts with the individual producers, it is fitting to dwell for a moment on the aid afforded by local organizations of various kinds. Many organizations have been most helpful in the past and will probably continue to be so in the future. But none has had so many different points of contact and such a general field of cooperation as the California Manufacturers Association. This association was organized in order to promote to better advantage joint industrial interests on the West Coast. It is closely allied to the California Industrial Council, which has representation from upwards of sixty trade associations. Through its own members and the Council, the California Manufacturers Association represents something like 3,000 different plants, employing approximately 250,000 men. It is therefore a very material element in the industrial organization of California. Naturally it is concerned with the general prosperity of the State, both present and future, and it is very much interested in preparedness planning, believing such measures worth while from a peace-time as well as from a war-time standpoint.

From the very start of procurement planning, the California Manufacturers Association has been sympathetic in attitude and anxious to help in whatever way it could be of service. To a large extent, this is due to its secretary, Mr. Fred Boegle, who is a Major in the Sanitary Reserve, and who has placed his records and files at the disposal of the War Department.

A rough summary of the scope of the Association's collaborative efforts includes a wide range. When procurement was in its early stages, Mr. Boegle, from his knowledge of industrial conditions, could give us, i. e., the seven procurement planning agents, a general survey of our field. When we were ready to call upon a manufacturer, he would furnish a letter of introduction and sometimes even convey us to the plant and make the introduction in person. He discovered sources of supply and, if personally unable to furnish information, told us whom to see. He even went so far as to obtain from the various War Department representatives a statement of their particular quotas with the idea that it would be possible to make consolidation of the War Department load in his office. Although the requirements of the different branches were not always stated in terms which permitted their reduction to the same common basis, still a great deal of work was done in the way of discovering over-laps in requirements and inconsistencies within the various branches.

Through Mr. Boegle, the Association secured a great deal of publicity for Procurement Planning and on various occasions, it sent its membership special bulletins dealing with industrial mobilization. It is engaged now in helping the War Department representatives locate manufacturers for certain items not readily placed with industry. In addition to this, the Association habitually addresses a letter to every new plant going into business in California urging it to cooperate in the Industrial Preparedness plans of the Department.

As a result there is received monthly by the procurement representatives, a list of firms, interested in mobilization, who have just established themselves in the State or believe that their product would be of value to the War Department in time of crisis. This list is an excellent means for keeping up to date with current changes.

On the occasion of the visit of the Assistant Secretary of War, the California Manufacturers Association participated with the Commonwealth Club of California and various patriotic societies in a luncheon of welcome. Later when Col. H. B. Ferguson, Director of Procurement in the Assistant Secretary's office revisited San Francisco the Association had a special luncheon in his honor at which the lines of cooperation in the San Francisco District were discussed informally and at length.

While the service rendered the cause of Industrial Preparedness by the California Manufacturers Association is quite marked in the line of material items and of keeping up to date, the greatest contribution of the Association is the procurement education of industry. Where the representatives of the War Department deal with a single manufacturer, the Association deals with hundreds, and, in addition, it reaches a field not readily accessible to those in the military service. To understand a little better what this means, it should be noted that, in the last war, it took almost exactly a year for the business man of the country to understand something of war procurement and of his relation to it. This delay occurred in spite of the very best intentions and efforts on the part of everybody, in spite of the support of the press, of government publications, of four-minute speakers, and of many kindred activities. The greatest value of the Association to Industrial Mobilization, as I see it, lies in the preparation of the public mind.

Not alone is this Industrial Preparedness of great peace-time value in helping industry to understand the facts about itself, but its value as a preparedness measure is almost incalculable. Space permits only two illustrations: One—During the World War, the War Department spent some fourteen billion dollars. At the beginning of that war, a knowledge of requirements such as we have today, would have saved us four billion dollars. At the beginning of that war, there was no one, comparatively speaking, who understood procurement even vaguely. Today there are 20,000 firms on the War Department lists with, let us say, fifty thousand men thinking about it collectively and in the same direction. Two—Whereas the dollar is now worth some sixty cents in terms of pre-war normal, it appears not unlikely that a proper planning can keep the dollar of any future war, from going below eighty-five or ninety per cent. of its then pre-war value.

Industrial preparedness is the cheapest and probably the best form of peace assurance that we have—it is doubtful if the money actually spent on it directly is one four-thousandth of the national revenue—but its effectiveness depends largely upon the attitude of industry and of business toward it. There is great need for an enlightened public opinion on this subject.

Stanford Illustrated Review.

The Arch, Stanford University.

The Ordnance Unit at Stanford University

Lieut. Col. Theodore J. Hoover, Ord. Res., U. S. A.

THE School of Engineering at Stanford University consists of the Departments of Civil, Electrical, Mechanical, Mining and Metallurgical Engineering, and the Department of Military Science and Tactics, with the establishment of a Department of Chemical Engineering in view.

The courses of study are so arranged that students can register for electrical, mechanical, metallurgical and chemical degrees, and at the same time carry and complete with very little extra work, the requirements for a commission as a Second Lieutenant in the Ordnance Reserve Corps.

The Department of Military Science and Tactics is an integral part of the School, and is looked upon at Stanford as an engineering department. With this arrangement, and the School as organized, Stanford would seem to be a good training ground for Reserve Officers.

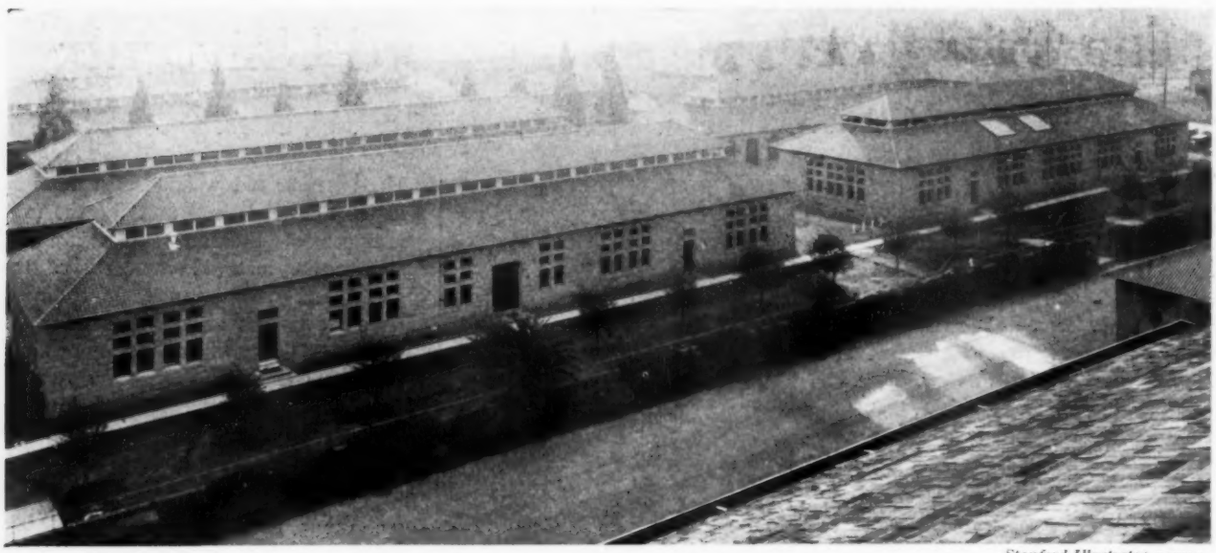
Lt. Col. Theodore J. Hoover, Ord. Res., Dean of Engineering, Stanford University.

The course of study for engineers in the School of Engineering consists of six years' work divided into a four-year undergraduate period, when the student will be registered in the school and not in a department, and ending with the degree of A. B. in Engineering; and a two-year postgraduate period, when the student will be registered in a department, ending with the degree of Engineer in Civil, Electrical, Mechanical, or Mining and Metallurgical Engineering.

This development of engineering education at Stanford, and the look into the future implied therein, is based on a conception of the engineer, and engineering as something vastly greater and more significant in modern life than just a man with technical training and a sort of a profession in which technology is the main ingredient. The engineer today, and much more so in the future, is and must be the man who controls the forces of nature and utilizes the material resources of the earth, and who organizes and directs human activities on these lines for the benefit of the race. As the stupendous total of our material assets constantly increases in bulk, and as man's environment comes more and more under his control, the engineer with each succeeding generation must take upon his shoulders larger and larger portions of the burden of civilization. If engineers of the future are to justify their name and fame, and the effort and expense put into their creation, there must be an improvement in their participation in public affairs; their sense of their public obligations must be further aroused, and a surer knowledge must be acquired of how to make their efforts effective.

In working out the details of the School of Engineering at Stanford, it has been definitely decided that the four-year curriculum cannot be utilized for a professional training, hence the School is placed on a six-year basis. It has also been recognized that engineering education generally has suffered from too great specialization in the first four years, to the detriment of fundamentals; this defect is corrected, it is hoped, in the curriculum of the School of Engineering. Leadership in the engineering professions has in the past, and will in the future, be attained by many four-year men who have been narrowly specialized, but we believe they attain leadership, not because of the specialization, but in spite of it. We believe the six-year man with his broader preparation will have a decided advantage in the race for leadership in his profession and in public affairs.

A Corner in the Ordnance Laboratory, Stanford University.



Stanford Illustrated Review.

Engineering Buildings, North End, Stanford University.

Whatever implied criticism of the past there may be in our desire at Stanford to make education in each succeeding generation better than that of its predecessor, it is no more than that normal ambition of the sons and daughters of all generations to do better than their fathers and mothers. There is nothing unkind in this implied criticism, if it really exists. We must build on their foundation, and their good work will endure. In definitely breaking away from the iron-clad bonds of the four-year curriculum and breaking away from too severe specialization in those years, and in laying a broader and more liberal foundation for professional work, we earnestly believe we are making a step forward in engineering education.

The six-year course is divided into two periods as follows:

1) A four-year undergraduate period devoted to the acquirement of a broad and liberal education. It is intended in these four years to cover as adequately as possible all those subjects, some knowledge of which all engineers find necessary in the prosecution of their profession, and to devote little time to the pursuit of the so-called professional or specializing or application courses. This four-year course is planned with the intention that the student who has not yet chosen his engineering specialty, or the student who is not even yet sure of an inclination to any engineering branch, may have, at the end of four undergraduate years, the alternative of going on in engineering in the two-year postgraduate curriculum to advantage if he so decides, or of leaving the University with a sound education which will fit him to enter into many engineering pursuits or any general business career.

2) Two years of postgraduate training in some chosen field of engineering as civil, electrical, mechanical, or mining or metallurgical engineering, in which specialization will be carried as far as time will permit. It is recognized now that another year would not be amiss to place these professions on a standing with those of medicine and law.

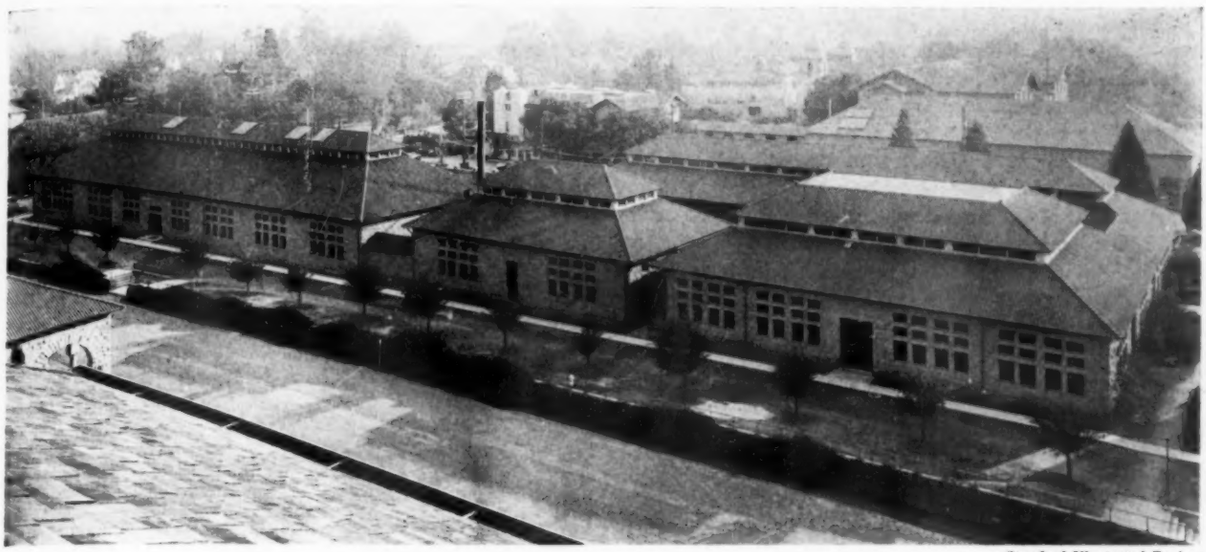
Four-Year Curriculum Leading to the Degree of Bachelor of Arts in Engineering

SUBJECT	Course No.	Autumn	Winter	Spring	Total Units
First Year					
Foreign Language		3	3	3	9
Linear Drawing and Lettering	C. E. 1, 2	..	1	1	2
Chemistry		4	4	4	12
Co-ordinate Geometry	Math. 10, 11	3	3	..	6
Calculus	Math. 21	..	..	3	3
Citizenship	Citizenship 1-3	4	4	4	12
Total		14	15	15	44
Second Year					
English Composition	Engl. 2a, 2b	3	..	3	6
Freehand Drawing	M. E. 11	3	..	..	3
Calculus	Math. 22, 23	3	3	..	6
Heat and Electricity	Physics 13, 14	..	4	4	8
*Mechanic Arts	M. E. 1, 2 or 3*	..	2	2	4
Descriptive Geometry	M. E. 10	..	4	..	4
History		3	3	3	9
Extemporaneous Speaking	Engl. 7	3	..	..	3
Elementary Machine Drawing	M. E. 12	..	..	3	3
Total		15	16	15	46
Third Year					
Theoretical Mechanics	C. E. 30, 31	5	5	..	10
Hydraulics	C. E. 106	..	..	5	5
Surveying	C. E. 20	5	..	..	5
Engineering Geology	Geol. 1a	5	..	..	5
*Electricity in Engineering	E. E. 102, 103	..	3	3	6
Elementary Accounting	Econ. 3	..	5	..	5
Principles of Mining	M. & M. 101	..	..	5	5
Electives		..	2	2	4
Total		15	15	15	45
Fourth Year					
*Mechanics of Materials	C. E. 110	5	..	..	5
*Pyrometallurgy of Iron and Steel	M. & M. 105	..	3	..	3
Exposition	Engl. 131	4	..	..	4
*Business Law	Law 100	4	..	..	4
*{Prime Movers or Elementary Machine Design	M. E. 123 / M. E. 113		5 or 4	..	5 or 4
*Engineering Economics	C. E. 130	..	..	3	3
Human Relations in Business		..	3	3	6
Electives		2	4 or 5	9	15or16
Total		15	15	15	45

*Courses are credited to the requirements for the Ordnance Course.

An analysis of the ingredients of the above four-year undergraduate curriculum may be made as follows:

Citizenship—12 units: Whatever the elements of a university education which leads to good citizenship may be, they are none the less elements of an engineer's training. The engineer stands throughout his whole professional career in the attitude of a public character. He stands definitely upon many occasions as an arbiter or



Stanford Illustrated Review.

Engineering Buildings, South End, Stanford University.

judge, and at times counselor and jury, between the public on the one hand and private interests on the other; and the engineer is often, to his immense personal discomfort, the buffer between capital and labor. The plea for courses in citizenship, economics, ethics, and political science, is as insistent as the plea for mathematics.

English—13 units: No smattering of English is adequate in the foundation for an engineering education. Drill in the use of this engineering tool should not only be present in the four-year foundation period but should follow through the whole six years.

History—9 units: Engineering preparation devoid of a proper historic perspective is futile. The record of what man has already accomplished in the matter of control of forces, utilization of resources, organization and direction of human activities, is as important as is the knowledge of the prior art in any scientific research problem. The record of what man has already accomplished is in the pages of history, with emphasis on the economic phases of history.

Language—9 units: The need of foreign language is obvious and unchallenged. The inadequacy and generally poor practical results of American instruction in language may justify less insistence on an effort to acquire facility in at least one foreign language than the need would indicate.

Economics—7 units: Such courses should be taken as will weave into the foundation for specialization the principles of economics, and there should also be some familiarity with secretarial duties, corporation finance, the accountancy of investment, and perhaps banking and foreign exchange.

Psychology—6 units: The principles of psychology and some application thereof to human relations, are essential.

Law—4 units: A minimum of at least one substantial course in business law will be insisted upon.

Mathematics—19 units: This should proceed through calculus or beyond, with more drill toward facility of use and stronger retention in memory. Selected students of exceptional ability should be carried farther than calculus.

Physics—18 units: A much broader preparation in physics, including the modern conceptions and experimental mechanics, is a necessity.

Chemistry—12 units: A thorough preparation, to include general inorganic, qualitative, and perhaps some quantitative chemistry, is a necessity.

Geology—5 units: At the very least there should be taken the fundamental principles of dynamical, structural, historical, and topographical geology.

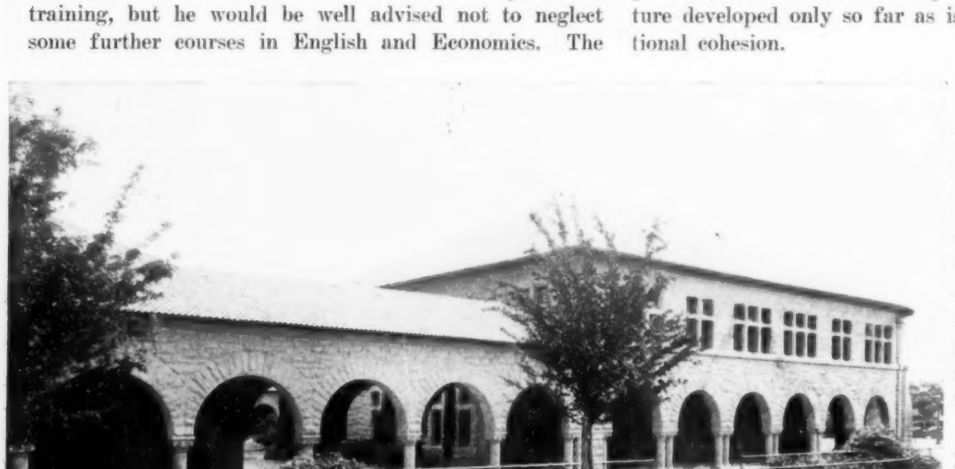
Engineering Fundamentals—25 units: These are drawing, shop, surveying, etc., 25 units. These subjects are com-

Field Artillery Unit, R. O. T. C., Stanford University. *Stanford Illustrated Review.*

mon to all engineers, and are at the foundation of all engineering work.

Engineering Special—21 units: Civil Engineering, 5 units; Mechanical Engineering, 5 units; Electrical Engineering, 6 units; Mining Engineering, 5 units. These courses are intended as a broad introduction or approach to the four main branches of engineering at present developed at Stanford, and are designed to help the student to choose among them his life work, and to form some idea of the field he is entering.

Electives—20 units: These may be used in two distinct ways. The student who has decided on his life work may use these electives if he wishes to begin his specialized training, but he would be well advised not to neglect some further courses in English and Economics. The student who has not decided on his life work may use these electives in any way he wishes.



Engineers' Building, Stanford University. *Stanford Illustrated Review.*

This four-years' work will lead to the degree of Bachelor of Arts in Engineering. There will be no further granting of the Degree of Bachelor of Arts in Civil Engineering, etc., for students who enter the University after May, 1926.

The four-year course may be classified, then, as follows:

	Units.
Humanistic studies	60
Science	54
Engineering Fundamentals	25
Engineering	21
Elective	20
Total	180

To summarize the ideas embodied in this six-year curriculum:

1) We shall have a broad and liberal foundation of mathematics, physics, chemistry, geology, English, history, language, psychology, business law and economics, and those fundamentals which are common to all engineers, which shall occupy 80 per cent. of the student's time for the first four years.

2) Specialization in these first four years will be reduced to a minimum and subordinated to the business of building the foundation. We will give the man the foundation, the principles, the background, and the method, and suppress the detail and technique of the professional activities of the moment. The choice of a profession is thus automatically delayed until near the close of the undergraduate period, when a greater maturity of judgment, a broader outlook on life, and more understanding of the world and its problems will probably result in fewer misfits.

3) Subjective ideas connected with engineering will be emphasized, and less attention will be given to the purely objective or mechanical phases of applied science.

4) The functional operations of the School or coordination in courses will be perfected to the greatest degree possible, and the line or disciplinary elements of its structure developed only so far as is necessary to insure functional cohesion.

5) The product of the first four years will be a man with a sound general education with only an engineering cast, but this preparation will be especially adaptable to further development in the next two years. The rather indefinite degree of A. B. in Engineering is considered suitable to mark this four-years' work.

6) During the last two years of the six-year period, specialization will be emphasized, but not to the exclusion of the ideas developed in 2, 3, and in part 4. Further attention will be given to the close affiliations of engineering and economics, and all possible external contacts between engineering and civilization will be maintained.

7) The product of this six-year period should be a man of broad outlook and high professional bent. He will have what we believe is essential; that is, not only some knowledge of his specialty but a knowledge of what relation it bears to life. This should result in an improvement in the engineer's participation in public affairs, and should arouse in these engineers a sense of their public obligations and a knowledge of how to make them effective, to the advantage of the engineer and the nation.

The Department of Military Science and Tactics

The Military Department at Stanford has been made a part of the School of Engineering. It consists of Field Artillery and Ordnance Units of the Reserve Officers' Training Corps, with Major Wm. D. Geary, Field Artillery, as head of the Department. The Field Artillery Unit has been maintained for several years while the Ordnance Unit was established only last year with Captain F. J. Atwood, Ord. Dept., in charge of the Unit. The Ordnance Unit is one of two maintained in the Ninth Corps Area. Its organization was found necessary in order to train reserve officers to fill existing and future vacancies in the Ordnance Reserve for this Corps Area.

Both the Field Artillery and Ordnance work is divided

into basic and advanced courses. No basic Ordnance course is maintained so all students enrolled in this unit take the Field Artillery basic course. Engineering and chemistry students who have completed the basic work are accepted for the advanced Ordnance course.

The basic course covers the first two years and consists of both practical and theoretical work. Completion of the practical work fulfills the University requirements for physical and military training. Full credit toward graduation is given for the successful completion of the theoretical courses. The practical work for the first year consists of individual instruction in dismounted drill, calisthenics, tent pitching, standing gun drill, cannoneer's drill, harnessing, driving in pairs, battery instruction in the composition and use of battery and battalion reconnaissance details, training of scouts and agents, individual instruction in map-making, battery instruction in mounted drill and tactical exercises combining and applying all the practical instruction given during the year. The practical work for the second year consists of individual instruction in fire control instruments; including the use of range finders, battery commander's telescopes, aiming circles and field glasses. Instruction in equitation, dismounted drill, standing gun drill, battery mounted and tactical exercises is continued from the first year's work.

The theoretical work of the Field Artillery basic course includes matériel, horse and stable management, topography, communications and artillery minor tactics, of which the Ordnance students take the first course (matériel).

The advanced Ordnance curriculum includes courses in matériel, ammunition and explosives, automotive engineering, ordnance engineering, physical and metallographic constitution of ordnance steels, ordnance administration, procurement of matériel, property accounting, military organization and military law. In addition to the foregoing Ordnance courses, students take selected engineering or chemistry courses in order to complete the Ordnance requirements. The course in matériel is in addition to that given in the basic course. It deals with the design and functioning of artillery matériel. Dr. G. B. Frankforter, a professor in the Department of Chemistry, gives the work in ammunition and explosives. Dr. Frankforter is a Major in the Ordnance Reserve and during the World War took an active part in ammunition and explosive work. The course in automotive engineering considers the fundamentals of automobile construction. It includes the engine and its accessories; carburetors, ignition, starting and lighting systems, cooling systems; the chassis and its component parts. The ordnance engineering course consists of lectures and problems dealing with the foundamental principles of gun design and the design of recoil and counter-recoil mechanisms. Calculations are made of stresses in gun carriages, gear trains and foundations used in different types of mounts. The lecture and laboratory course dealing with physical and metallographic constitution of ordnance steels is conducted in the Department of Mining and Metaliurgy by Professor Welton J. Crook. A very complete laboratory is available for this course which is only open to Ordnance students. Full credit toward graduation is given for all Ordnance courses.

The advanced Field Artillery curriculum includes field artillery firing, motor transportation, organization and tactics, military history and policy of the United States, military law, administration and practical work in advance of the basic practical courses. Credit toward graduation is given to the Field Artillery students for the completion of the foregoing courses.

Ordnance Laboratory, Stanford University.

The United States Government places at the disposal of the University for instruction purposes the necessary number of horses and horse equipment; a complete 75-mm. battery with fire control instruments and reconnaissance instruments; motor equipment and a well equipped Ordnance laboratory containing Caterpillar tractors; artillery repair truck with tools and equipment, French 75-mm. gun, American 75-mm. gun, 155-mm. howitzer, 37-mm. gun, trench mortar, machine guns, rifles and pistols of both obsolete and the latest models; Le Boulengé chronograph, sectionalized ammunition, fire control instruments and numerous other equipment.

During the summer, normally between the junior and senior years, the students attend a six-weeks' camp which, during the past, has been held at Camp Lewis and Fort Casey, Washington. Five units of credit are given for the satisfactory completion of this camp.

Upon completion of the Reserve Officers' Training Corps course and graduation from the University, the student is given his commission as a Second Lieutenant in the Field Artillery or Ordnance Reserve Corps.

Ordnance Reserve Officers at Stanford University

Lt. Col. Theodore J. Hoover, Dean of School of Engineering; Maj. Geo. B. Frankforter, Professor of Chemistry; Capt. Arthur B. Domonoske, Executive Head of Department of Mechanical Engineering; Capt. Fred'k G. Tickell, Associate Professor of Petroleum Engineering; 1st Lt. Boynton M. Green, Assistant Professor of Mechanical Engineering.

Tripp Board Urges Ordnance Educational Orders

"The Ordnance Problem is the Crux of National Defense Today"

AS the result of a report of its Committee on Industrial Preparedness, headed by Gen. Guy E. Tripp, Chairman of the Westinghouse Company and a Vice-President of the Army Ordnance Association, Congressional legislation permitting the placing of "educational orders" for the manufacture of non-commercial classes of munitions was urged by the Board of Directors of the National Association of Manufacturers at its quarterly meeting in New York City, December 17, 1926.

"Practically all the knowledge needed to organize and employ an expanded army," says the Tripp Board report, "is automatically maintained by the peace-time activities of the country with the all-important exceptions that (a) knowledge of the *use* of arms, and (b) knowledge of the *manufacture* of arms, must be stimulated in times of peace in order to be available adequately and promptly in event of emergency.

"In order to be able to attain mass production as soon as possible in the critical first months of a possible emergency, it is absolutely necessary that the manufacturer, in time of peace, should have an opportunity to run through his plant a small order, only sufficient in size to work out the 'bugs' in the paper plans prepared by the manufacturer in cooperation with Army officers. All the manufacturer asks is that he be reimbursed for his out-of-pocket expenditures."

The full text of the Tripp Board report follows:

Preliminary Report

NATIONAL ASSOCIATION OF MANUFACTURERS COMMITTEE ON INDUSTRIAL PREPAREDNESS

Findings:

1. Continued prosperity in America is dependent upon assurance of enduring peace.

2. America's most recent experience indicates that the surest guarantee of peace is a readiness to defend the national sovereignty, *i. e.*, preparedness.

3. The foreign policy of America involves no dreams of conquest nor any aggressive action toward any foreign power whatsoever, and, therefore, preparedness in America connotes only *defensive* measures.

4. America maintains, in proportion to national wealth guarded, the smallest standing army of any of the fifty principal countries of the world. In proportion to population, whose peace and prosperity are at stake, America likewise maintains the smallest Regular Army, even smaller than that allowed Germany by the Treaty of Versailles, which was specifically intended to render her impotent as a military power.

5. Preparedness, on an efficient and economical basis, requires years for complete achievement and unremitting attention for its proper maintenance. Hastily improvised preparedness is needlessly wasteful of human life, and unnecessarily expensive.

6. Unpreparedness has failed dismally in ever keeping America out of war. Proper preparedness, however, according to the best military opinion, might conceivably have precluded the necessity for American participation in the World War, and, in any event, would have shortened the duration of the conflict which cost a million dollars an hour for over two years.

7. Prior to the World War, preparedness was taken to mean only plans for the mobilization of man power, failing to take into consideration the fact that mobilized manpower unless adequately supported by munition power was entirely ineffective.

8. The great demonstrated lesson of the World War was the fact that America, relying solely on her own resources, could organize and train troops at a rate which far exceeded the capacity of the country to arm and equip them—further, that the rate of manufacture of non-commercial articles of ordnance was the controlling factor of the entire war program.

9. Practically all the knowledge needed to organize and employ an expanded army is automatically maintained by the peace-time activities of the country with the all-important exceptions that,

(a) Knowledge of the *use* of arms, and
(b) Knowledge of the *manufacture* of arms

must be stimulated in times of peace in order to be available adequately and promptly in event of emergency.

10. It is contrary to the traditional policy of America to maintain an extensive civilian industry devoted primarily to the manufacture of ordnance, and it is improbable that America will ever look with favor on measures intended to encourage the growth of a civilian industry dependent upon the manufacture of war material for its profits and existence.

11. Under existing conditions, the Ordnance Department of the Army, for example, while possibly adequate for such development work and such production in restricted quantities as may be necessary during peace times, is deficient in commissioned personnel when considered as the nucleus of knowledge around which must be built the tremendous industrial machine which, in the event of war, requires a preponderant proportion of the entire industrial war effort.

12. Commissioned officers of the army appear to be available to the number of 1700 devoted exclusively to mobilizing man power or problems involved in the *use* of arms, whereas but 24 have to date been assigned to the far greater and more difficult task of educating industry in the *manufacture* of arms.

13. The present program for National Defense is, therefore, out of balance to a critical degree, due to the wide disparity in the attention now being devoted to problems involving mobilization of man power, as contrasted with the attention being devoted to problems involving the mobilization of munition power—particularly in the non-commercial classes such as ordnance and aviation material.

14. Due to the wise recommendations of the Morrow Board now being carried into effect by appropriate legislation, the problem of aviation material is proceeding toward ultimate solution, while leaving the problem of securing ordnance material as the crucial question in considering National Defense today.

15. What America needs most at present is a greater knowledge of ordnance manufacture and all artificial obstacles to the acquirement of this knowledge by American industry should be removed forthwith and every effort made through legislative enactment to stimulate the acquirement of this vital knowledge.

16. In this connection attention is invited to the fact that in order to build up the American aircraft industry for purposes of National Defense, the Morrow Board states, on page 29 of their report, as follows:

> "We recommend that: * * *
>
> (4) Government competition with the civil industry in production activity be eliminated except in those projects impractical of realization by the civil industry * * *."

This wise recommendation has been adopted as the permanent policy of the War Department. It will obviously tend to spread to the commercial world a knowledge of the design and manufacture of airplane material and render the solution of the aircraft problem immeasurably easier. The same reasoning should apply to the ordnance problem.

17. The present plans of the War Department for mobilizing industry for the production of ordnance in the event of emergency are excellent in every particular, and *if* carried through to conclusion in all particulars will not only shorten the duration, and therefore the cost of a possible future conflict, but by strengthening our defences, will actually make the possibility of America being involved in war more and more remote in direct ratio with their degree of completeness.

18. Of the elements of industrial mobilization, the determination of requirements, both as to quantities and dates wanted, and the preliminary allocation of requirements to existing facilities, have been completed in a most effective manner. The actual completion of Emergency Production Plans by ordnance reserve plants with the degree of accuracy and detail necessary to permit them to be used as the basis of determining probable schedule of output, as well as Secondary Requirements for buildings, equipment, raw material, etc., is a task of considerable magnitude for each factory involved.

19. Existing obstacles to the completion of Emergency Production Plans are due largely to the scarcity of trained ordnance officers available for assignment to specific plants, to supply necessary technical data and otherwise assist manufacturers in this exacting work which is expected to be done without direct remuneration from the Government.

20. The Ordnance Problem is the crux of National Defense today, inasmuch as our citizens can be called to the colors ever so smoothly, can be housed and clothed and fed ever so completely, can be paid ever so generously, and furnished with all the care that surgical, medical and dental science can afford, and yet will not become soldiers until they are furnished with the tools of their trade, viz.: Ordnance.

21. Ordnance is, of course, but one of several essentials of a modern army, but all the others are present in adequate supply or can be obtained in much less time than that required for the production of ordnance which, therefore, becomes the controlling factor of the entire program for National Defense.

Recommendations:

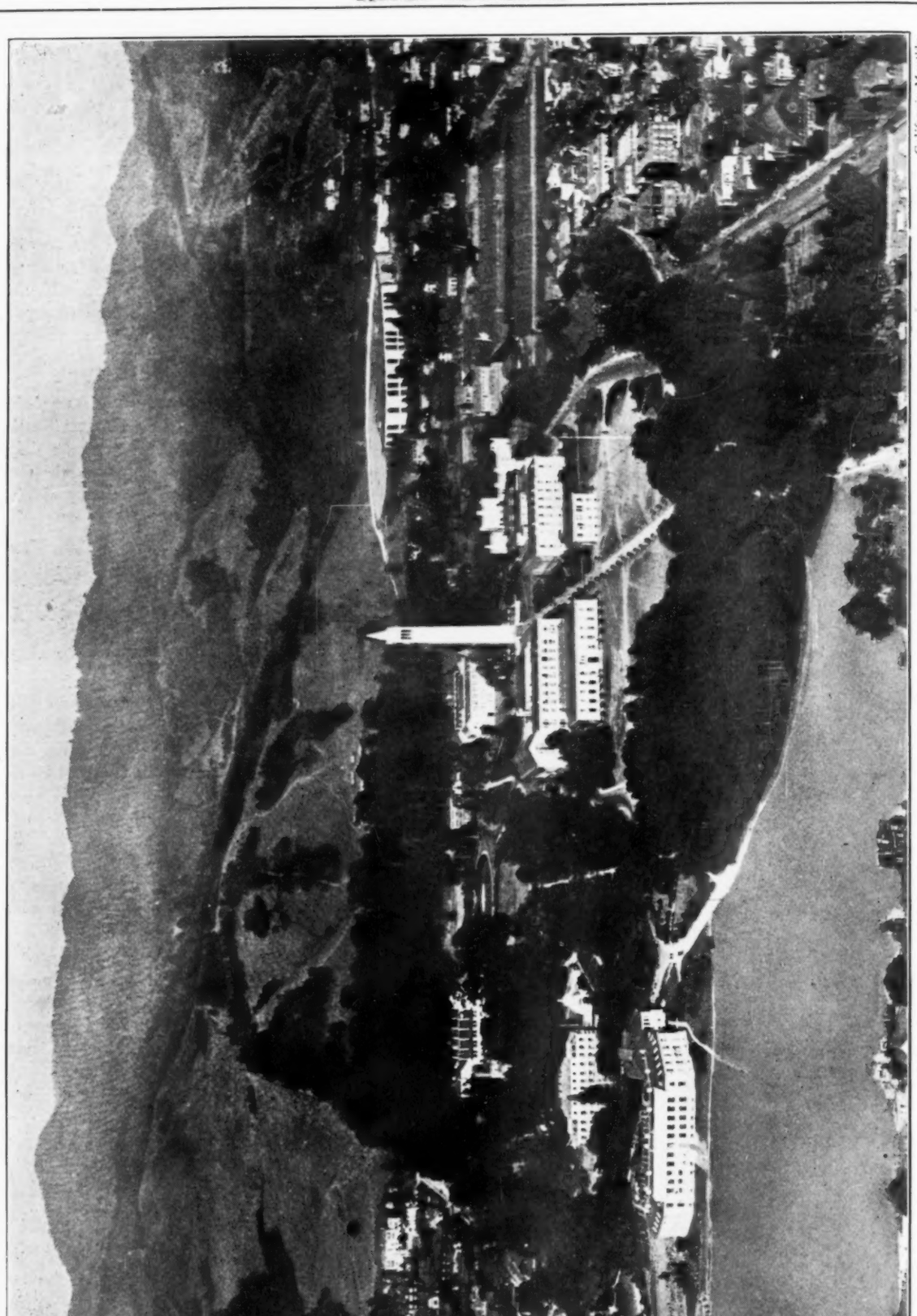
In order to provide a greater reservoir of knowledge for the solution of problems involved in the mobilization of munition power, particularly the non-commercial phases thereof such as the manufacture of ordnance, the Committee on Industrial Preparedness of the National Association of Manufacturers recommends:

(1) That the National Association of Manufacturers endorse the organization of the proposed "Munitions Battalion" as described by the Honorable Hanford MacNider, the Assistant Secretary of War, at the Annual Meeting of the Association held in New York City on October 7, 1926; that the necessary appropriation of Federal funds for the purpose of training annually four hundred college students, who have satisfactorily completed at least three years of their courses, in the elements of military science and tactics, and in addition in the basic procurement problems of the Army, be urged upon the Congress now in session; and that, due to the need for immediate action in the premises, Honorable Frank A. Scott, during the war Chairman of the War Industries Board, be requested, subject to the approval by your Board of Directors, to present to the President of the United States the recommendations of the Association in this connection.

(2) That the Ordnance Department of the United States Army be progressively increased over a period of years, in order to provide personnel of a proper degree of permanency equipped with the vitally important knowledge of the design and manufacture of ordnance, necessary to permit present plans for Industrial Preparedness to be carried to a successful conclusion.

(3) That the provisions of Sec. 5a of the National Defense Act approved June 3, 1916, as amended by the Act of June 4, 1920, to the effect that "He (the Assistant Secretary of War) shall cause to be manufactured or produced at the Government arsenals or Government-owned factories of the United States, all such supplies or articles needed by the War Department as said arsenals or Government-owned factories are capable of manufacturing or producing upon an economical basis," be rescinded and that legislation be secured permitting the placing of "educational orders" with commercial manufacturers for the production of non-commercial articles of ordnance with due consideration for knowledge of the art acquired rather than as at present, upon a competitive basis as to price.

(Signed) GUY E. TRIPP, *Chairman.*
C. S. WALKER, *Secretary.*



California Monthly.

An airplane view of the Campus, University of California, Berkeley, Calif.

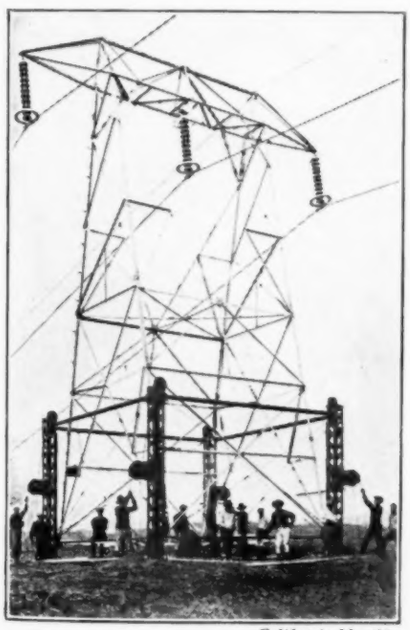
The University of California—An Ordnance Asset

Robert Sibley, B. S., E. E.

TEN years ago a stranger on San Francisco Bay asking his way to the University of California, would be told that it was "somewhere in Berkeley" and that Berkeley was just north of Oakland. Today, his guide will merely point his finger at the *Stadium*, the stately white walls of which, on a clear day, contrast sharply with the green or brown of the Berkeley Hills. And as our stranger enters its northern portal his eyes will doubtless be drawn to a large tablet upon which the memory of California's war-dead is inscribed in enduring bronze. If a game is in progress the tumult and the shouting may seem a bit incongruous with *their* sacrifice—it is then well for him to remember the famous saying, that "The Battle of Waterloo was won on the cricket-fields of Eton and Harrow." But while we must never forget our dead, it is right that we also appreciate the efforts of our living. Perhaps, but for their devotion and skill, the bronze list would have been much longer; perhaps their achievements in the future may make another list unnecessary.

ROBERT SIBLEY
Professor of Mechanical Engineering
University of California.

From an *industrial* standpoint statistics show that the Pacific Coast did not participate heavily in the World War. To be sure certain phases of war work were almost exclusively assigned to us, but as compared with the eastern manufacturing states, the proportion such phases bore to the whole was not large. As a result, California's participation took a different but by no means unimportant form. The Golden State still has a solid agricultural foundation, and we all know that the *man* behind the gun must be fed as well as the gun itself. Deficient in coal, California contributed a large share of the precious liquid which propels the modern ship, tank, tractor and automobile. California's men were in every branch of the nation's service at home and abroad, on sea, land or in the air. The campus itself was a training camp for Ordnance, Air and other services. From the laboratories many a professor went out in olive-drab. Many of those who remained reduced their academic work to a minimum and plunged into the hundreds of research problems involved in the arming of a whole country's manhood.



California Monthly

The World's Largest Interconnected Power System.

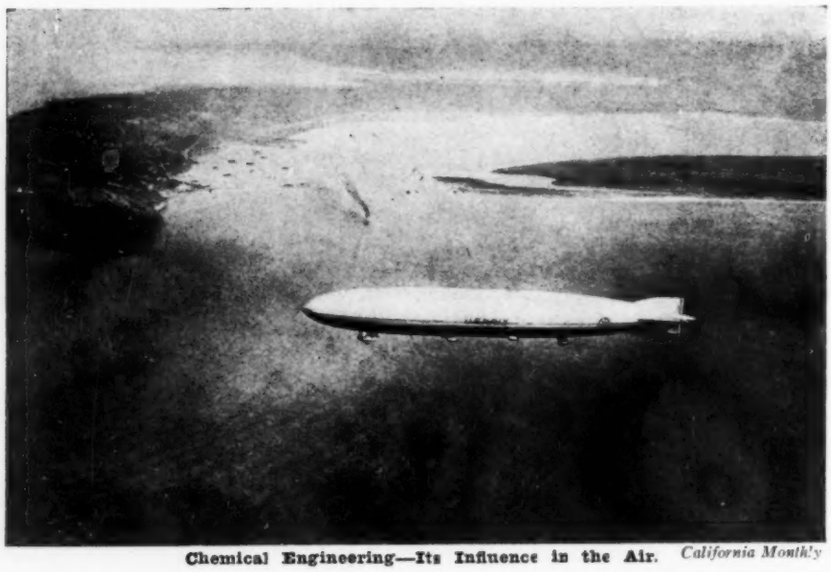
Electrical generating plants from Portland, Oregon, in the North down to the Mexican Border, on the South—all interconnected—drawing upon nearly two million horsepower in installed capacity deliver annually nearly five billion kilowatt hours of electrical energy. The two great Universities, the University of California and Stanford University, have always maintained a substantial leadership in the development of this great power supply on the Pacific Coast. The picture shows the jacking up process in operation, wherein the voltage of the great Big Creek System of the Southern California Edison Company is being raised from 150,000 volts to the record voltage of 220,000 volts without the necessity of shutting down the power supply. H. A. Barre, '97, of the University of California, was the Vice President and Executive Engineer in charge of this work.

But it is not the purpose of this article to dust off the laurels of the past. Rather should it be to project the possibilities and responsibilities of the future. Should history ever be so unfortunate as to repeat itself, and especially should Mars ever stir up the peaceful Pacific, California industry might be its predominant contribution to the nation's defense. Slowly but surely, manufacture is pressing westward, taking advantage of the natural resources and economic factors found here. Already the University of California is alive to the new situation, and is preparing her sons for its control.

The "College" of California was incorporated April 13, 1855, less than eight years after the discovery of gold at Fort Sutter. Its growth was rapid but sound, its patrons wise and generous. Today its sons are scattered all over the world, but when they return they find their Alma Mater not only more beautiful than ever, but wielding a more profound influence upon the life of the state and the nation.

From a national defense angle it is easiest to view the University of California in terms of its own academic subdivision. So large is this organization and so scattered over the state, that we must confine our interest for this time to the parent establishment at Berkeley. Indeed we must ignore the liberal arts, legal, medical, commercial and agricultural departments and restrict our field to the four colleges of Mechanics, Chemistry, Civil Engineering and Mining.

While these colleges are separate in an administrative sense it must not be understood that they are "water-tight compartments." The student of



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Moving eastward to the beautiful Hearst Mining Building we might visit for a moment with Dean Frank H. Probert, A. R. S. M., under whose leadership many a young man has gone out to delve into Mother Earth for the basic materials of war and peace—iron, copper, gold, silver and oil. Here again we find a man with a distinguished war record in his expert field. Equally well-known is his work on the commission charged with the appraisal of the damage to French mines by the retreating Germans. A modest man, the Dean prefers to tell about his graduates rather than about himself.

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A stope half a mile below the surface of the great gold reef of South Africa.

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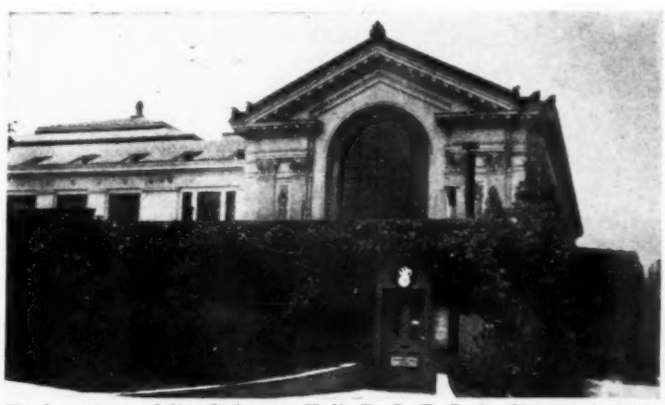
Lastly we enter the beautiful building known as Gilman Hall, home of the College of Chemistry. Dean Lewis, Ph. D., greets you in the friendliest fashion, but you can see that he has been thinking, concentrating. Seeing him in the environment of a thoroughly modern chemical research laboratory, it is not difficult to visualize him as a Colonel in the Chemical Warfare Service in the A. E. F.

Into this environment of high engineering and scientific attainment, it has been the good fortune of the Ordnance Department to drop a small seed of an idea—that of showing the University of California where it fits into the nation-wide plan of Industrial Mobilization, especially from the Ordnance standpoint. So in 1923 the seed began to germinate; one little root found a home in Mechanics, another in Chemistry and the third in Mining. The little plant has grown quickly in the kindly soil and the first fruit has been gathered.

The Ordnance Unit at the University of California

Maj. R. W. Pinger, Ord. Dept., U. S. A.

THE general tendency of a great technical supply corps, such as the Ordnance Department, is to emphasize the vast matériel problem of modern warfare in comparison with the more widely understood one of personnel. We say that all men needed are born at least twenty-one years before the beginning of hostilities, whereas most of the weapons required must be manufactured after the declaration of war. We sometimes forget that *within* the matériel problem is a special personnel one without the solution of which no plans for industrial mobilization can possibly succeed. Of course for the time being the Ordnance personnel problem is solved by the very men who read this journal. Could they but acquire immortality, the writer's work would be useless and this article without meaning.



Headquarters of the Ordnance Unit, R. O. T. C., in Old North Hall, University of California. Doe Memorial Library in background.

In defining the relation between Units of the Reserve Officers' Training Corps and the Ordnance Department Reserve a recent War Department publication states:

"To supplement and maintain this Reserve the Ordnance Department is depending largely upon the Ordnance Units of the R. O. T. C. to develop a Corps of Reserve Officers with basic military and Ordnance training, whose early professional education has been technical and whose later experience, after graduation, will qualify them for scientific, technical and administrative duties in the Ordnance Department."

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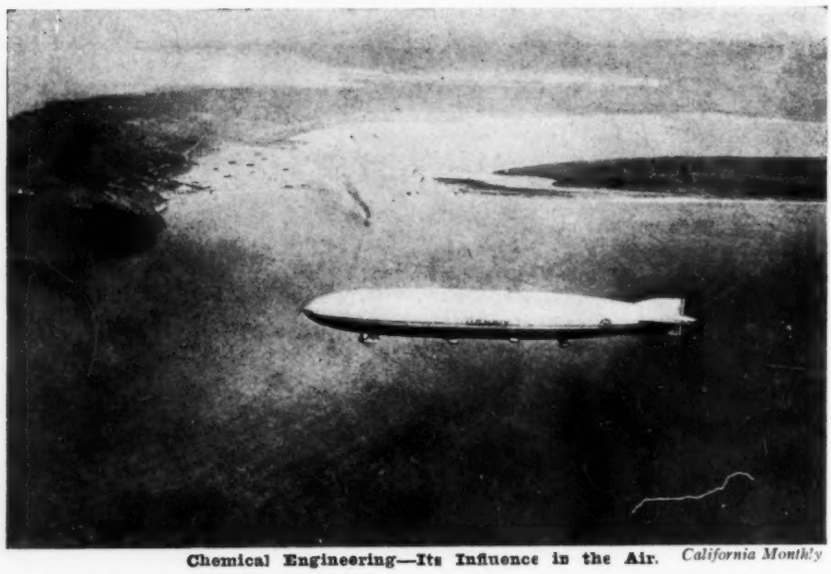

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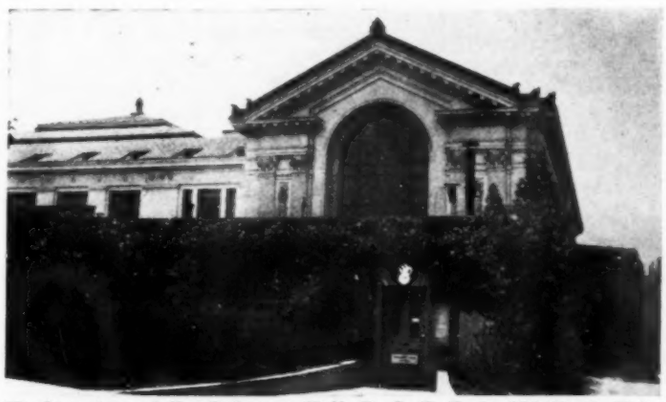

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nance problems into the *regular academic curricula* as far as possible. However this principle may have worked at other institutions, it did not seem adapted to the University of California. Here the demand has constantly been for a four-year engineering course, with the consequent paring away of merely technological instruction to make room for more adequate fundamental training. For example, the College of Chemistry no longer offers a course in the Chemistry of Explosives. It gives its students basic chemical training fitting them to become chemists of explosives, ink, matches, oil or any other commodity manufactured on the Coast now or in the future. So right from the beginning our unit offered a minimum course including two hours of Ordnance instruction weekly for two years. For those who had the time, three additional hours of laboratory work were added.

In 1926, based on the experience of all the Ordnance Units throughout the country, a new program was adopted by the War Department. This schedule which has gone into effect with the new students entering advanced military work in August, 1926, offers the following Ordnance curriculum for the *first* year. The hours refer to those spent with the instructor exclusive of those in preparation for classes.

Junior Year—1st Semester

Ammunition and Explosives:	**Hours**
The general Ordnance problem; industrial mobilization	1
The Ammunition problem	1
Grenades	1
Bombs	1
Projectiles	1
Fuzes and boosters	1
Primers, bags and cases	1
Small arms ammunition	1
Design and manufacture of ammunition	1
Smokeless powder	2
Compound propellants and black powder	1
Trinitrotoluene and ammonium picrate	1
Miscellaneous high explosives and initiators	1
Shell loading	1
Pyrotechnics	1
Test and storage of ammunition	1
Supply of ammunition	1
Midterm examinations	2
Total	20
Ordnance Matériel (Small and Automatic Arms):	
Rifles	2
Pistols and revolvers	2
Machine guns and automatic rifles	2
Design of small and automatic arms	1
Manufacture of small and automatic arms	1
Total	8
Current Ordnance Problems (Lectures by outside experts, etc.)	2
Total for semester	30

Junior Year—2nd Semester

Ordnance Matériel:	**Hours**
Artillery weapons in general	2
Cannon	2
Recuperators and recoil mechanisms	2
Carriages for cannon	2
Study of actual artillery matériel	3
Manufacture of cannon	2
Manufacture of carriages	1
Fire control and optical equipment	3
Manufacture of optical glass and instruments	1
Antiaircraft artillery	1
Tractors	2
Tanks	1
Self-propelled mounts	1
Mobile Ordnance shops	2
The raw material problem	1
Total	26
Midterm examinations	2
Current Ordnance problems	2
Total for semester	30

Textbooks

Military Explosives (W. D. D. No. 947).
Handbook of Ordnance Data (O. O. No. 1861).
Handbook of American Coast Artillery Matériel (O. O. No. 2042).
Handbook of Artillery (Mobile, etc.) (O. O. 2033).
Notes on Ammunition (Yale Pamphlet).

It will be observed that in the junior year the entire Ordnance field is covered from a general descriptive standpoint, thus preparing the men for assimilating the greatest possible benefit from the summer camp which follows. The course consists of two weekly lectures liberally illustrated by lantern slides, charts and models. The laboratory, which also serves as lecture-room, is now equipped with almost every article of Ordnance used by divisional troops including a 75-mm. field gun (French), 37-mm. field gun, and 3-inch trench mortar, artillery repair truck (less chassis), and a large assortment of fire-control instruments, machine guns, automatic and shoulder rifles, pistols, revolvers, etc. Some sectionalized ammunition components have been furnished by the Ordnance Department, but our laboratory students had already sectionized and mounted a most interesting assortment of projectiles, bombs, powders, fuzes, small arms ammunition, grenades, pyrotechnics and so on. They have also constructed models of recoil mechanisms and display boards for disassembled rifle and pistol. Students of chemistry have manufactured (in their own laboratories) numerous samples of tetryl, ammonium picrate, nitroguanidine, etc., which have later been given Trauzl block and Shelby tube tests.

A corner in the Reading Room, Ordnance Unit, R. O. T. C., University of California.

The unit is entitled under regulations to several tractors and a liberal assortment of guns and howitzers larger than the 75-mm. However, space for these is unobtainable. The armament used by the Coast Artillery Unit, permanently installed in a fenced inclosure, is therefore employed where the smaller weapons are insufficient for the purpose.

In teaching Ordnance matériel, the author has followed the general policy of the university by emphasizing fundamental principles rather than the specific construction of the standard types of Ordnance used in the recent war. To achieve this end the beginning of an excellent Ordnance Museum has been made. For example, in studying the rifle, model of 1903, there is available for comparison the Krag-Jorgenson, old Springfield, German Mauser, Spanish

Mauser, French Lebel, Russian 3-line, Ross, Enfield, etc. In studying ignition even an old "flint-lock" and a "pin-fire" are on hand to show the development of the principle as well as its present consummation. When breech-blocks are under investigation an obsolete 3.6-inch field mortar provides a "Freyre" obturator as a fore-runner of the modern "DeBange." Mastery of the Browning machine gun is accompanied by a simultaneous appreciation of the Maxim, Vickers, Benet-Mercie, Lewis, Colt, Chauchat and Hotchkiss. In this way students acquire an increased respect for the achievements of the past and realize that

South end of Ordnance R. O. T. C. Laboratory, University of California.

Ordnance science is one of continuous, never-ending development. Reading of improved types in ARMY ORDNANCE and other technical publications, they are able to appreciate much more fully the solution of the problems involved, and perhaps even to suspect the source of the inventor's inspiration.

For many recent additions to the "Museum," Mr. Bourne, Major Spiers, Lt. Col. Stephenson, Captain Finley and others are recipients of our gratitude. Doubtless many readers of ARMY ORDNANCE will gladly donate still further specimens when they realize the excellent use to which such gifts or loans can be put. The various manufacturing arsenals have also been most kind to us in sending samples of their wares in process of manufacture, photographs of manufacturing equipment and so on. Half of the Unit's office is arranged as a reading room in one corner of which the nucleus of an Ordnance library has been established. Bound volumes of ARMY ORDNANCE, almost a complete file of Ordnance pamphlets, technical regulations and so on are under constant perusal with a view to oral or written report. Textbooks for extended loan to students are also available. All in all, the Ordnance Unit at U. C. is now equipped in a way quite unsuspected by those who observe only the humble exterior of our little abode.

A few weeks after the close of the junior year we find the men in camp, most of them having gotten there by the group-purchase of ancient but still energetic motor vehicles of the ubiquitous type. For the past three years the time has been divided between Camp Lewis and Fort Casey, Washington. At the former all problems involving the use of tanks, tractors, mobile shops and small arms have been given as well as all artillery firings involving the use of a land range. At Fort Casey the firing problems requiring the use of a water-range are solved. Between the two places a practical knowledge of the functioning of all kinds of Ordnance is obtained.

Of course, it is greatly regretted that distance prevents the two Ordnance units on the Pacific Coast from enjoying the company of all the others at the Aberdeen Proving Ground each summer. There is no comparison between the facilities at the latter and those which must necessarily be improvised at an isolated small post like Fort Casey. Still the work done at the latter with student-constructed chronograph screens, home-made recoil-time measuring devices and so on, has been of a high order, well worth the expenditure of the ammunition involved.

The camp instruction (six weeks) is probably the most important element in the whole course, but its facilities are perhaps the least satisfactory so far. It is very difficult for an officer a thousand miles away, already deeply engrossed in his university work, to plan, assemble equipment for, and execute such a project. It would seem preferable for such reponsibility to rest on an officer permanently resident at or near the camp site, utilizing the university officers as assistants and occasionally giving the latter a summer off to perform work which cannot possibly be done during the regular semesters of instruction. A camp near San Francisco would be easier to administer from this standpoint but unfortunately the bay of that name is usually so densely covered with fog in July that very little artillery firing would be possible—certainly no time-conserving schedule could be followed. In this connection it may be said that from the student standpoint, the farther away the camp the better—many men enjoy leaving their native State for the first time on that occasion. All things considered, the Lewis-Casey combination is perhaps the best possible solution for the Pacific Coast. If it could be permanently adopted as a matter of policy and the necessary facilities permanently assembled and stored at the two places, much of the hard work which must now be repeated each year, would be obviated.

When the men return to college for their senior year they have absorbed from the lecture room, reading room, laboratory and camp, an excellent all-around knowledge of Ordnance. They have also completed some engineering subjects of greatest Ordnance importance such as "strength of materials," "analytic mechanics," etc. They are entering the study of thermodynamics and other matters related to interior ballistics. It is thus fitting that the most important feature of the senior year's Ordnance work is "Ordnance Engineering." The complete curriculum is as follows:

SENIOR YEAR—1ST SEMESTER

Elementary Ordnance Engineering:	Hours
Ordnance measurements	1
Theory of explosives	1
Interior ballistics	3
Exterior ballistics	3
Design of cannon	3
Design of recoil mechanisms	2
Design of carriages	1
Materials of Ordnance construction	1
Mid-term examinations	1
Total	16
Commercial Law (with special reference to Government contracts)	8
Military Organization (with special reference to types and quantities of Ordnance needed)	4
Current Ordnance problems	2
Total for semester	30

SENIOR YEAR—2ND SEMESTER

	Hours
Property accounting and Ordnance Financial Procedure	8
Procurement, Storage and Issue	4
Company Administration (especially that of Ordnance Field Service organizations)	7
Military Law	7
Mid-term examinations	2
Current Ordnance problems	2
Total for semester	30

It will be noted that practically all the instruction in Ordnance Administration is delayed until the last quarter of the course. The reason is that we always have a small number of students who for reasons of health, finance and so on, fail to complete their course. It has been thought best to give the most important parts of the work first making it possible for students in this class to secure their commissions in later years by examination. As a matter of fact, methods of administration are subject to great change as years go by, so that what is learned in college is believed to be of general rather than specific value to a young reserve officer.

This article would not be complete without giving the reader an idea of the kind of students who are attracted to the Ordnance Unit, or the characteristics of the regular Ordnance personnel who are most likely to enjoy and render the best service with them. As intimated before, the University of California is greatly interested in military education and has welcomed the establishment of courses covering the needs and interests of all types of students. The adventurous may enter the Air Corps Unit; the engineering or chemically inclined, the Coast Artillery or Ordnance; the large bulk of "letters and science" men of course go into the Infantry. We have a Naval Unit taking men from all colleges but of course preferring those from the engineering group. The Ordnance Unit like the others must play the game and secure its development without impairing that of other and older organizations. As now arranged, all men who are eligible for the Ordnance course (mechanical and mining engineers and chemists) take the basic Coast Artillery course, with others not eligible. At the end of the sophomore year, men who prefer tactical work, drilling as infantry and artillery, etc., are encouraged to go on in the Advanced Coast Artillery course. There is however a large residue of men to whom such activity makes no particular appeal—men who are far more interested in the design, manufacture and test of a gun than in its tactical employment. Frequently the best students (from an academic standpoint) feel it unwise to devote nearly a sixth of their time to a tactical course when the technical program of the Ordnance Department fits into their curricula with so much less disturbance. So it may be said that the composite characteristics of our Ordnance students are—

(a) An intense interest in the mechanical, metallurgical and chemical features of warfare.

(b) A much smaller interest in "squads-right" and "squads-left."

(c) A great pleasure in handling actual articles of Ordnance and in discussing troublesome points informally with the instructor.

(d) A growing tendency to discuss personal problems of a general nature with the Ordnance instructor, this being almost a thing of the past with the academic professors on account of the huge size of classes.

It is easy to see that the corresponding qualities of the Ordnance Officer in charge, and in a general sense of his enlisted assistant, must be—

(a) An accurate and all-embracing knowledge of Ordnance, present, past and future—theoretical and practical.

(b) A thorough enjoyment of young men and a sympathy with their aims and problems.

(c) An ability (especially at camp) to secure fullest cooperation without resort to the "hard-boiled" types of discipline—leadership rather than drivership.

(d) An academic record and personality which will command the respect of the other members of the faculty, upon whom must rest much dependence for support.

The writer lays no claim to the possession of these virtues with the possible exception of (b). However he is enumerating them here with the hope of attracting the attention of his successors.

War Department Business Council Meeting

THE advice and assistance received from the War Department Business Council, which held its annual meeting in Washington, December 7, 1926, is proving of great value in the administration of the procurement branches of the Army. The men who compose the council are executives of some twenty of the leading industrial firms of the United States. They attend the meetings at their own expense to inspect and advise as to the purchasing organizations and methods of the various supply branches of the Army thus making available to the Army services which would be beyond the reach of any one commercial organization.

At the meeting the Council declared that present personnel, organization and methods of the Army supply branches are equal to those in large corporations and that the War Department's goal of "making every dollar do its full duty" is being rapidly approached.

The members of the Council are: Col. Leonard P. Ayres, Vice-President, Cleveland Trust Company, Cleveland, O.; Brig. Gen. John J. Carty, Vice-President, American Telephone and Telegraph Co., New York, N. Y.; Howard Coonley, President, Walworth Company, Boston, Mass.; Lieut Col. F. S. Dickinson, President, Beeton, Dickinson & Co., Rutherford, N. J.; George F. Dryden, President, Dryden Rubber Co., Chicago, Ill.; Brig. Gen. Clinton G. Edgar, President, Continental Sugar Co., Detroit, Mich.; Col S. M Felton, Chairman, Great Western Railway, Chicago, Ill.; C. W. Nash, President, Nash Motors Co., Kenosha, Wis.; Lieut. Col. Oscar W. Smith, President, Park, Davis & Co., Detroit, Mich.; Col. William C. Sprnance, Vice-President, E. I. Du Pont de Nemours & Co., Wilmington, Del.; Col. William A. Starrett, Vice-President, Starrett Brothers, New York, N. Y.; Gerard Swope, President, General Electric Co., New York, N. Y.; Ralph Van Vechten, Vice-President, Continental Commercial Bank, Chicago, Ill., and Brig. Gen. S. Herbert Wolfe, Consulting Actuary, New York, N. Y.

Pacific Coast Ordnance R. O. T. C. Camp, 1926

Capt. F. J. Atwood, Ord. Dept., U. S. A.

THE first phase of the 1926 Ordnance camp was held at Camp Lewis, Washington, where Brig. Gen. Robert Alexander was camp commander and Lieut. Col. G. H. White was Executive Officer.

Ordnance R. O. T. C. students at Fort Casey, Washington, Training Camp, 1926, measuring velocity and time recoil curve with 37-mm. field gun.

The institutions represented at camp were California Institute of Technology; University of California; University of California, Southern Branch; University of Hawaii; University of Idaho; University of Montana; Montana State College; University of Nevada; University of Oregon; Oregon Agricultural College; Pomona College, Stanford University; University of Utah, University of Washington; Washington State College; University of Wyoming; Cornell University; Yale University; Culver Military Academy; New Mexico Military Institute; Oklahoma Agricultural and Mechanical College and University of Tennessee.

The branches of the Service represented and the number from each were Infantry, 247; Engineers, 63; Field Artillery, 97; Ordnance, 25; Cavalry, 13; Medical and Dental Corps, 54. A total of 499 cadets attended camp. The Ordnance cadets were from the University of California and Stanford University.

Activities started at the R. O. T. C. camp on June 11th when the Executive Officer, Supply Officer, Adjutant and part of the non-commissioned staff arrived to prepare the way for the incoming cadets who were due to report on the 18th. Physical examination, drawing equipment and the policing of barracks were the order of the day.

Instruction for all organizations began on the following Monday morning with physical drill following reveille. Physical drill was given at this time each day throughout the camp. Following the policing of barracks, displaying of equipment and breakfast the Ordnance students engaged in an hour of infantry drill and inspection of barracks. Following this hour the work differed from day to day. The organization was divided into sections and instruction was given in the maintenance of tractors. The cadets actually disassembled and repaired tractors which were out of service due to burned out bearings, broken clutches, etc. Every cadet was given individual instruction in the operation of trucks, tanks and tractors.

Accompanied by the 3rd Ordnance Company (Maintenance) two very interesting days were spent in the field with the mobile repair shop. This furnished instruction in convoy duty and maintenance under field conditions. It also gave the cadets an opportunity to make camp, use their mess kits and sleep in pup tents. The shop, consisting of about 20 vehicles, was set up and some repair work was done. Following the maneuvers with the mobile repair shop a week was spent on the rifle range where instruction and record practice with the rifle were conducted. Each man also fired the pistol for instruction but not record practice. This completed the first phase of the Ordnance Camp at Camp Lewis.

The next phase was conducted at Fort Casey, Washington. Fort Casey is located on Puget Sound about fifty miles from Seattle. The Fourth of July holiday intervened during the journey to Fort Casey so the cadets had from Saturday until Tuesday to visit places of interest. Many went to Vancouver and Victoria, B. C.

Ordnance R. O. T. C. students at Camp Lewis, Washington, Training Camp, 1926, studying the why and how of a tank.

On Tuesday morning, July 6th, White reconnaissance cars were used as transportation to take the cadets to Seattle where the harbor boat from Fort Worden was waiting to complete the journey to Fort Casey. The boat trip was very enjoyable but all were glad to get to their destination where they arrived at 3 o'clock in the afternoon. Equip-

ment was then drawn and the barracks put in order preparatory to the two weeks of hard but very interesting and instructive work which was to follow.

The instruction at Fort Casey began on the morning of July 7th with an inspection of the Fort and instruction on fire control instruments. The majority of the two weeks was spent in the simulating of proof firing artillery matériel. Two cadets were assigned to take charge of the preparation and firing of each problem. In this way every student was given the responsibility of preparing for a problem. The 3-inch (15 pdr.) antiaircraft gun, 3-inch (15 pdr.) seacoast gun, 155-mm. gun, 12-inch mortar and 10-inch disappearing gun were fired. The majority of the problems were fired to determine the powder pressure, the muzzle velocity of the projectile and the rate of recoil and counter-recoil of the gun. The effects on the ranges of the projectiles with percentage changes of the propelling charges were determined. An Aberdeen Chronograph was used to measure the muzzle velocities and two different types of instruments, made by students at the University of California, were used to measure the rate of recoil and counter-recoil. Some of the data obtained from these problems are now being used in connection with the theses of some of the students who attended camp.

Ordnance R. O. T. C. students at Fort Casey, Washington, Training Camp, 1926, firing and maneuvering seacoast mortars.

Instruction was given in the use of hand and rifle grenades. The remains of the practice fragmentation grenades were in great demand for souvenirs. A night program of pyrotechnics proved to be very interesting as well as instructive. Flares, position lights and signal rockets of assorted colors were used for the fireworks. This completed the work at Fort Casey and the return trip to Camp Lewis was made July 20th. The harbor boat from Fort Worden afforded a very pleasant trip to Seattle, leaving Fort Casey at 7 o'clock in the morning and arriving at Seattle at eleven. Reconnaissance cars were waiting there to complete the journey to Camp Lewis.

Back again at Camp Lewis the last phase of camp was started with an inspection of the magazines and storehouses. The instruction was continued with the observation of the firing of a 75-mm. battery by the Field Artillery R. O. T. C. The firing was observed from the battery position and the adjustment of fire from an O. P. near the target. Instruction in the demolition of high explosive shells was given, jointly with the Engineer R. O. T. C. The demolition work included the destruction of 8-inch howitzer, 155-mm. and 75-mm. high explosive shells. The craters made and the fragmentation of the projectiles were studied. A 155-mm. gun and a howitzer were disassembled, then reassembled and tests made of the recoil mechanisms, which completed the problems for the camp.

Work was not considered all important. Athletics and social entertainment helped to make the camp a success. Athletics were organized and with the support given by representatives of every R. O. T. C. organization, baseball, swimming and track teams competed with and won from some of the best teams in camp and the vicinity. The different R. O. T. C. organizations also competed among themselves. Baseball was probably the most popular of sports, but track, tennis, boxing and wrestling all furnished their share of amusement. A field day was scheduled for the latter part of camp and included a tug-o'-war, relay races, equipment races and many other events.

A very important part of camp was the entertainment of the cadets. Committees were appointed to take charge of athletic and vaudeville entertainment. In addition to the local talent obtained from the R. O. T. C. organizations, excellent outside talent was obtained from Tacoma. Series of shows and contests were given beginning with the first week of camp. The American Legion of Tacoma entertained the cadets at camp for an evening with a good show consisting of plenty of comedy and good music. The college night show was staged as the last performance and every school did its utmost to put on the best act for this final entertainment. Music for all the entertainments was furnished by an R. O. T. C. orchestra. The R. O. T. C. dances given every Wednesday night from 8:00 to 11:00 o'clock were popular events of the camp. Further diversions for the cadets were found in visits to the battleships anchored in the harbor at Tacoma and in an excursion to Mount Rainier. The trip to the mountain is always an outstanding event of the camp. The following forenoon was spent in hiking up the mountain and viewing the glaciers. After lunch the return trip was made to Camp Lewis, arriving there in time for dinner. The program for the last two days of camp, July 28th and 29th, included military competitions, an R. O. T. C. camp review, returning of property and the paying of the cadets.

Lieut. G. W. Hirsch, Ord. Dept., U. S. A., was assigned to and ably assisted with the instruction of the Ordnance camp. Lieut. J. W. Freeman, Ord. Dept., who was in command of the associate unit, the 3rd Ordnance Company (Maintenance), helped in many ways to make the work of the camp a success.

Experiments on Belville Springs

THE Ordnance Department for some years has been conducting experiments to secure improvement in the design and manufacture of Belville springs. Springs of this type, which are discs assembled with concave sides in opposition, are used in hydro-pneumatic recoil mechanisms where it is necessary to stop, in a restricted space, the recoil of a heavy gun.

Very little data is available in this country on the design, correct manufacture and heat treatment of these springs, and it has been necessary to conduct experimental work to establish the best practice. Considerable improvement already has been effected, but experiments will be continued.

An Ordnance Reserve Officers' Training Camp in California

Maj. Walter H. Adams, Ord. Res., U. S. A.

THE writer has had the privilege of attending two Ordnance training camps. The first one proved to be extremely interesting but the second was an improvement on the first. If the Regular officers, who are responsible for these camps, are going to keep up such rate of improvement an extremely hard task is ahead of those who will have to plan later camps.

The camp was opened at Benicia Arsenal, May 16, 1926, 35 Ordnance Reserve officers having reported for duty as students.

The reserve officers were quartered in the hospital ward and in one of the officer's quarters which was vacant. A few of the late arrivals had to stay at a hotel in Benicia.

Maj. Walter H. Adams, Ord. Res.

Mess was served by the cooks of the Ordnance Companies. The cooking was excellent. The only complaint was one heard quite frequently at reserve training camps, namely, "The food is so good and I am so hungry after my exercising that I eat too much."

After reporting, renewing old acquaintances and meeting new friends, every one was asking the question, "Where is Rockville?" As this was given as the destination of our "hike" and overnight camp many a guess was made as to its location. The distance from Benicia varied from about 15 miles to something over 70. Finally one enterprising young captain enquired of a native of Benicia, while attending the motion picture show, and located Rockville, thus relieving the feelings of a few who feared they could not stand a hike of 60 or 70 miles. More of our overnight camp later.

Upon reporting we found that our mentor, instructor and friend was to be Lieut. Geo. W. Hirsch. He never failed us in any of these capacities. He was always ready to explain, always available, always cheerful and had a large fund of ordnance information with which to answer questions.

Tuesday morning at 7:00 the Lieutenant appeared and blew his whistle. The thins, mediums and fats appeared sans shirts, sans leggings and sans hats but otherwise fully clothed. For 10 to 15 minutes we were double-timed, given setting up exercises and similarly mistreated. Under this treatment the thins began to get fat and the fats began to get thin. However one week of this was not sufficient to produce any startling results.

A small amount of infantry close-order drill was included in the schedule in order to familiarize the officers with the new drill.

The work of the camp was carried on as shown on the schedule of instruction.

COURSE OF INSTRUCTION FOR THE ORDNANCE RESERVE OFFICERS' TRAINING CAMP, BENICIA ARSENAL, CALIFORNIA, MAY 16 to 30, 1926.

May 16 (Sunday)

En route.

May 17 (Monday)

8:00 to 12:00	Physical examination; general inspection of Arsenal; talk, "Organization and Functions of Benicia Arsenal." — Major Partridge.
1:15 to 1:40	Drill.
1:45 to 4:30	The 155-mm. Howitzer. Dismantle, examine liquid and air (nitrogen) cylinders, pistons and recoil control. Reassemble, fill with liquid and air; tests to determine liquid level and air pressure; safety features; obturation; adjustment of sights.—Lieut. Hirsch.

May 18 (Tuesday)

8:00 to 12:00	Property Accountability and Responsibility, AR 35-6520 Receipt, Shipment and Issue of Property, AR 35-6560 Expendable Property, AR 35-6620 Lost, Damaged or Unserviceable Property, AR 35-6640 Property Records, AR 35-6700 Blank Forms Pertaining to Property Accounting, AR 35-6720 Note: Instruction by discussion, problems and use of forms.—Mr. O'Donnell.
1:15 to 1:40	Drill.
1:45 to 4:30	Inspection of storage and issue of ordnance supplies. Groups A, B, C, D, E, F, G, H, J, K and L (Storehouses 71, 69, 64, 49). Storage, inspection, checking and packing property; disposition of unserviceable property; inventories; marking shipments (AR 850-20).—Mr. Bowerman.

May 19 (Wednesday)

8:00 to 9:15	The Ordnance Provision System.—Mr. Gieffels.
9:30 to 10:30	Talk and discussion, "Organization of a Field Army, Army Corps and Infantry Division with special reference to the organization of the Ordnance office and duties of the Ordnance officer of each of these units."—Major Partridge.
10:30 to 12:00	Inspection of mobile shop equipment of an Ordnance Maintenance Company (Light and Heavy).—Lieut. Hirsch.
1:15 to 1:40	Drill.
1:45 to 2:15	Talk, "Ammunition Supply in Peace and War," and description of depots and parks. Illustrated by moving pictures.—Major Partridge.
2:15 to 4:30	Inspection of ammunition magazines; methods of storage; safety rules; types of magazines; breaking down unserviceable small arms ammunition; destruction of "duds" and unserviceable ammunition.—Lieut. Hirsch.

May 20 (Thursday)

8:00 to 9:00	Talk, "Arsenal Administration."—Mr. Mann.
9:15 to 9:45	Ordnance Drawings.—Mr. Mendler.
10:00 to 12:00	Five-ton tractor and six-ton tank matériel.—Capt. Merrill.
Afternoon	Recreation. Pistol firing for those desiring it.

Ordnance Reserve Officers in training at Benicia Arsenal studying the 155-mm. Howitzer.

May 21 (Friday)

8:00 to 12:00 and 1:00 to 3:00	Small arms Shop. Repair of rifles, pistols, machine guns, automatic rifles, etc., including such problems as assembly of new rifle barrel to receiver; fitting and adjusting new front sight to rifle; star gaging; determination of leaks and soldering of water jacket on Browning machine gun; bluing and browning of rifles, etc.—Capt. Merrill, Mr. Eversole.
3:00 to 4:30	Demonstration firings of automatic rifle, machine gun, 3-inch Stokes trench mortar and 37-mm. gun.—Capt. Merrill.

May 22 (Saturday)
and
May 23 (Sunday)

Preparation for road march. March to Rockville; camp; field depot; return.

We put on our fatigue clothes and dismantled a 155-mm. howitzer and then tried to put it together again. We learned how to disassemble a Browning machine gun and automatic rifle. We also did the same to the automatic pistol. Later we were given the opportunity to fire the machine gun and pistol.

Under the able tutelage of Warrant Officer O'Donnell we learned the reasons for and when to use an O. S. & D. report. The warehouses were inspected, special attention being given to methods of packing for shipment, checking shipments and the steps to be taken in case of shortage or damage. The methods of storing ammunition, piling, keeping track of ammunition lots and the reports required were explained. War reserve material was inspected in the warehouses and the means adopted to keep this in condition, with limited funds, were noted. The methods used in breaking down unserviceable ammunition and the destruction of duds was explained and then the destruction was actually executed. Explanation of Ordnance drawings and standards was given and illustrated by drawings in use at the Arsenal.

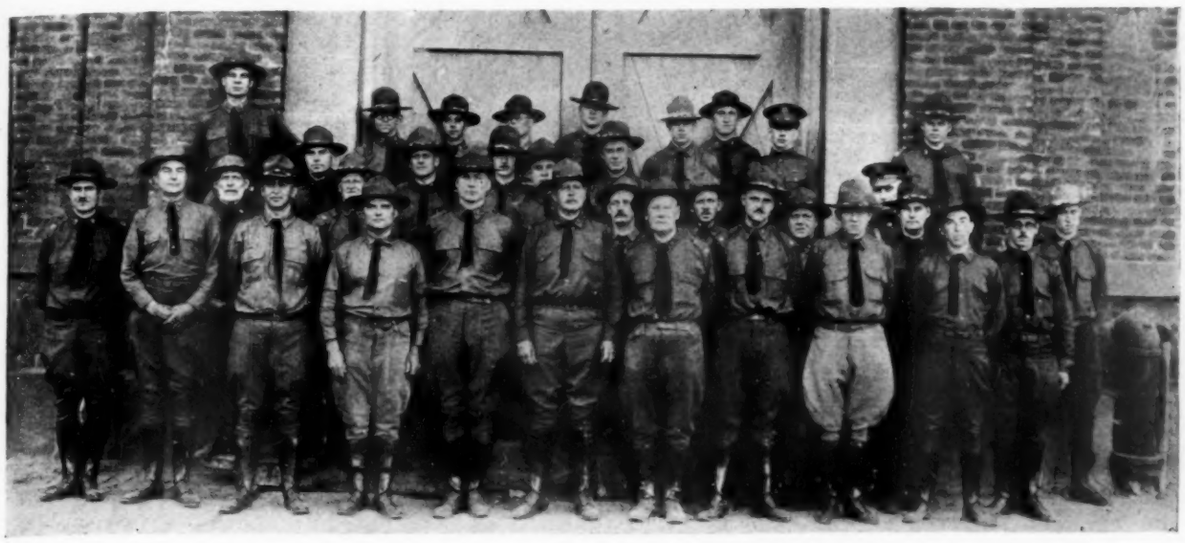
Every officer was given instruction in the operation of the 5-ton tractor and the 6-ton tank. Each one of us sat in the operator's seat and had the satisfaction of seeing and feeling the machine in motion under his direction. It was necessary several times for a group to scatter in all directions to avoid being run down by some one who had not yet received his license to operate motor vehicles.

Possibly the outstanding feature, because of its novelty to a large number of officers, was our "hike" to Rockville.

On Saturday morning we reported to Lieutenant Hirsch as per instructions, with our three blankets and shelter half, pins, rope, tent pole and mess kit. We had previously been instructed that no sheets or pillows would be allowed. However it was later discovered that both of our senior officers had violated orders and taken pajamas. No mention is made of several juniors who did likewise. (It might be added, in passing, that the aforesaid pajamas were put on over all other clothes that night as it was one of the coldest that we had during our tour of duty.) Our packs were very military (?) being rolled in shelter halves but carried without pack carriers and haversacks.

We found, much to our relief, that our "hike" was to be made in two army trucks which were ready for us. We also discovered a rolling kitchen trailing along behind one truck so did not worry over grub. Rockville proved to be about 15 miles from Benicia and situated in a small, pleasant valley, almost surrounded by hills.

After pitching camp in a very military manner and after a good dinner, Lieutenant Hirsch lined us up and explained that the commanding general of the army corps had ordered us to establish a corps ammunition dump at this place. We were supplied with a list of the ammunition that was to arrive and a table giving maximum size of piles and the spacing. We were divided into groups of three. Each group was ordered to prepare a map of the location showing the distribution of the ammunition in piles or huts, and showing new roads that would have to be constructed. It was left to the officer in charge of each group to devise ways and means. Two solutions were finished that afternoon and the remainder were ready for Maj. C. E. Partridge, Commanding Officer of Benicia Arsenal, upon his arrival the following morning.



Group of Ordnance Reserve Officers who attended Training Camp at Benicia Arsenal, May, 1926.

The statement of the problem was as follows:

PROBLEM

Assume: (a) 1st Army Corps holding general area, Napa Soda Springs—Vacaville.
(b) Corps Commander (G-4) in consultation with Corps Ordnance Officer decides to establish Corps Ammunition Park in valley on west side of county road at Rockville.
(c) Ammunition to be carried as per attached sheet.

Required: (a) Draw map of area to be used—Scale: 1 in. = 200 ft.
(b) Plot thereon layout of park showing location of ammunition piles and huts and the quantity of each item therein, using the key letters assigned, for example: Indicate a pile of 1,000 H. E. Shell, Mark III, for the 155-mm. gun, as follows: A-1,000.

The night will be remembered by many if not by all. It was the first night in many years spent in the open on the ground by a majority of the officers present. The following morning reveille was not needed to get us out. However, a few setting up exercises took out the stiffness.

After this interesting week at Benicia Arsenal the following officers reported to Col. Bruce Cornwall, Chief of the San Francisco Ordnance District:

Lieut. Cols. Stephenson and Masury; Majs. Adams, Copley, Reynolds, Spiers, Wieland; Capts. Bliss, Harshman, Robinson, Armitage, Criglar, Domonoske, Finley, Holt, McIntyre, Nilan, Doble; 1st Lieuts. Green, Hudson; 2nd Lieuts. McDonald, Anderson, Chambers, Shriber and Josephs.

After reporting on Monday morning the first training period was devoted to a lecture by Major J. A. Dorst, of the Corps of Engineers, on "Industrial Mobilization." Major Dorst touched on phases of industrial mobilization that differ from those of the Ordnance Department.

Following this lecture the District War Game was played under the assumptions of the following Special Order:

WAR DEPARTMENT
SAN FRANCISCO DISTRICT ORDNANCE OFFICE
58 Sutter St.,
San Francisco, Cal.

May 15, 1926.

SPECIAL ORDER NO. 10.

DISTRICT WAR GAME

1. The Chief of Ordnance has directed that a war game be carried on in the San Francisco Ordnance District during the period May 24-30, 1926, to test industrial plans.

2. *Basic Assumptions*

The following general assumptions are made:

(a) The present actual conditions in districts with respect to war orders, status of negotiation, allocations, etc., will hold.

(b) The game will embrace the first 20 days of a major emergency.

(c) Control of the seas will be retained for 30 days.

(d) The principal theater of operations in the first six months of the war will be the New England States and the State of New York.

3. *Special Assumptions*

(a) A telegram reading as follows has been received by the District Chief at 8 P. M. Sunday, May 23, 1926:

"Major emergency effective at once. Take all necessary steps to expand office. You are designated contracting officer. Negotiate all contracts necessary for present war orders. Fixed price contracts only for present. Other types will be furnished within 15 days. Fifty thousand dollars made immediately available to you for office expansion, travel, and other incidental expenses under O. S. 1926, Ord. 122-P-52-5-6. Appropriations for manufacturing contracts estimated by this office and will be made available about M plus 15. No obligation of funds except

as specified in Ord. 122 above will be incurred until official notice is given that procurement authorities have been issued. Summon reserve officers scheduled for duty in the first month and furnish this office names for confirmatory orders. Apply to Real Estate Service representative at your Corps Area headquarters for lease of suitable office space for district office."

(b) M-Day is Monday, May 24, 1926.

(c) The Ordnance Office is making arrangements to secure the importation of as much strategic raw material as can be secured in 30 days.

The trainees pitch camp at Rockville, Calif.

(d) By M plus 20, Congress will pass an enabling act authorizing the President to waive certain restrictive legislation. It may be assumed that all laws which might hinder the procurement program will be included.

(e) No manufacturing appropriations are available, except small amounts remaining under this year's funds which will go to arsenals. Sufficient money to cover war orders now on hand in districts will be available on M plus 16, and it may be assumed that procurement authorities for necessary amounts will be received on that date.

(f) Reserve officers due for duty on M-Day may be summoned immediately. Report to Ordnance Office of names may be assumed to bring confirmatory telegram by M plus 5.

(g) The Real Estate Service may be assumed to have established a representative at each Corps Area headquarters who will handle all real estate operations in the Corps Area.

(h) The Signal Officer at the 9th Corps Area headquarters will attend to communication facilities on request.

(i) Office equipment and supplies may be purchased locally from additional Ordnance Service money which will be available M plus 16.

(j) The District Chief is authorized to make contracts and to designate his authority when necessary.

(k) The local Civil Service district headquarters may be assumed ready to function on matters pertaining to civilian personnel.

(l) The District Chief has been authorized to make temporary appointments of civilian personnel at once.

(m) Ordinary fixed price contracts will be used as far as practicable at the outset. By M plus 15, it may be assumed that adjustable price, agency, and construction contract forms are also available. District Chiefs are familiar with the adjustable price contract and the ordinary peace-time fixed price type.

BRUCE CORNWALL,
Colonel, Ord. Reserve, District Chief.

The remainder of the morning session was spent in a discussion of the Mobilization Plans of the District Office. Each officer was assigned to a duty just as he would be if reporting in case of a major emergency.

In the afternoon representative manufacturers about San Francisco, who have been allocated to the Ordnance Department, were present to participate in the game. A round table discussion of small arms and artillery manufacture was carried on. The difficulties that would be encountered today to secure the schedule of production needed was discussed.

Tuesday morning was devoted to a lecture on "Ordnance Procurement," by Major Brett. He showed the difference between the Ordnance problem of procurement in an emergency and the problems presented by most of the other supply branches of the Army. The Ordnance Department has practically no peace-time manufacture to fall back on. It is a case of utilizing existing facilities as far as possible—and then creating new ones during the emergency. The remaining time of the session was used to finish the discussion of the Mobilization Plans of the District Office.

The war game was continued in the afternoon session. Artillery and ammunition manufacture were again discussed.

Lt. Col. Masury, one of the student officers on duty, gave a very instructive lecture on "Ordnance Explosives and Propellants." This lecture was illustrated by samples and drawings. It was followed by a lecture on "The Raw Material Problem," by Maj. R. W. Pinger, Ord. Dept., in charge of the Ordnance unit of the R. O. T. C., at the University of California. Major Pinger brought out the shortages that may exist in raw materials if we should lose control of the sea during a war.

Next we visited the plant of the Caterpillar Tractor Company at San Leandro, California.

After the completion of our work in the District Office our next duty was under Maj. T. J. Hayes, Ord. Dept., 9th Corps Area Ordnance Officer, at the Presidio of San Francisco.

Our first day here was marked by a lecture on "Post War Developments in Ordnance," by Major Hayes. He brought out the recent improvements, many of which have been preserved for our future reference in ARMY ORDNANCE. This lecture was followed by one on "Chemical Warfare Developments and Plans," by Lieut. J. F. Smith, C. W. S.

In the afternoon an inspection trip was made to the Coast Defenses of San Francisco on the San Francisco side of the Bay. The entire system of operation of the defenses from guns to mines, storage of ammunition, power plants and plotting rooms was carefully explained by Capt. E. L. Barr, C. A. C., Ordnance Officer of the Harbor Defenses. This trip was interesting as it brought us in

contact with the using services, thus presenting another angle of the Ordnance problem.

The next morning we had a conference on the Correspondence Courses under the direction of Maj. S. P. Spalding, Ord. Dept. As a result of this conference all officers, not already enrolled, signed enrolment applications. After the conference Major Pinger talked about the Ordnance Reserve Officers' Training Corps.

After the morning conference an inspection trip was made to Crissey Field to inspect the work being done in synchronizing machine guns and airplane propellors.

After luncheon we crossed to the north side of San Francisco Bay in an Army launch to inspect the coast defenses. Arrangements had been made to watch the firing of the guns at Fort Barry but this had to be postponed because of poor visibility.

At Fort Barry we had an opportunity to see the loading of shell with Explosive D. As some shell had been found defective all shells were being opened, inspected and refilled. A portable loading plant had been improvised and shells were being filled by enlisted men of the Coast Artillery, under the supervision of the Ordnance Department.

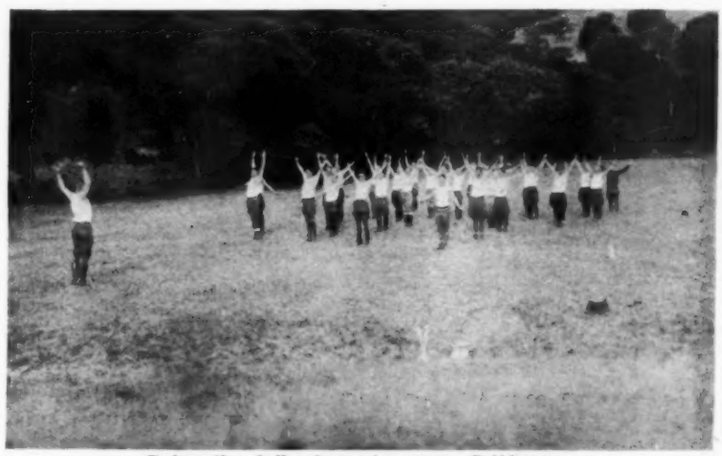
The following morning we again reported to Major Brett for a discussion of the tour of duty and suggestions for future camps. In order to stimulate criticism he requested each officer to specify one item that should be eliminated in order to shorten the course.

To Capt. Harry Holt, one of the student officers, were assigned the duties of finance officer. He carried through very successfully.

The social events of our tour of duty included a luncheon and reception given by Major and Mrs. Partridge to the class at Benicia Arsenal; a luncheon of the California Post of the Army Ordnance Association at the Commercial Club, San Francisco, and a dinner at the Claremont Hotel, Berkeley. The dinner was given by the class as an expression of appreciation to our instructors, who were our guests.

Following the dinner we spent a pleasant evening as the guests of Major and Mrs. Charles F. Wieland in their delightful home in Berkeley.

The following officers were on duty during the camp: Lt. Col. Frank J. Stephenson, Berkeley, Calif.; Lt. Col. Frederick L. M. Masury, Santa Barbara, Calif.; Maj. Walter H. Adams, Burbank, Calif.; Maj. Almon Copley, Burlingame, Calif.; Maj. Albert A. Hedge, San Francisco, Calif.; Maj. Oscar F. Reynolds, Seattle, Wash.; Maj. James Spiers, San Francisco, Calif.; Maj. Charles F. Wieland, Berkeley, Calif.; Capt. George R. Bliss, Carpenteria, Calif.; Capt. Clarence C. Harschman, Los Angeles, Calif.; Capt. William E. Robinson, Long Beach, Calif.; Capt. Arthur N. Armitage, Pittsburg, Calif.; Capt. Joseph W. Criglar, San Francisco, Calif.; Capt. Arthur B. Domonoske, Berkeley, Calif.; Capt. Dozier Finley, Berkeley, Calif.; Capt. Harry O. Holt, San Francisco, Calif.; Capt. Harry J. McIntyre, Seattle, Wash.; Capt. Eric Nilan, San Francisco, Calif.; Capt. Donald H. Atherton, Berkeley, Calif.;



Doing the daily dozen in sunny California.

Capt. George W. Ridgeway, Reno, Nevada; Capt. Richard C. Waterman, Jr., Redwood City, Calif.; Capt. Francis L. Hutsler, Beverley Hills, Calif.; Capt. William A. Doble, Berkeley, Calif.; 1st Lieut. Roy L. Baber, San Jose, Calif.; 1st Lieut. Boynton M. Green, Palo Alto, Calif.; 1st Lieut. Carroll D. Hudson, Los Angeles, Calif.; 2nd Lieut. C. B. McDonald, Blythe, Calif.; 2nd Lieut. Lawrence A. Anderson, San Francisco, Calif.; 2nd Lieut. Frank W. Chambers, Berkeley, Calif.; 2nd Lieut. Earl W. Shriber, Berkeley, Calif.; 2nd Lieut. Forrest M. Pearce, Oakland, Calif.; 2nd Lieut. Henry C. Snyder, Pasadena, Calif.; 2nd Lieut. Albert G. Bagley, Jr., Fresno, Calif.; 2nd Lieut. Howard H. Josephs, Oakland, Calif.; 2nd Lieut. Milton G. Mauer, San Francisco, Calif.

In closing the writer desires to express the appreciation of the class to our instructors of the Regular Army who did everything in their power to make our tour of duty agreeable and instructive. If at a future date we should be called into active service in time of emergency we would all like to serve with such men as we were privileged to be associated with during the last two weeks of May, 1926.

Caliber .22-45 Gallery Practice Pistol

THE Infantry Board of the Army has recently completed a test of the caliber .22-45 pistol and conclusions have been reached that this weapon is suitable for use as a gallery practice weapon.

There is no difference in the outward appearance of the experimental pistol and the caliber .45 pistol except in the size of the bore. The chief difference in the two pistols is in the component parts of the slide. The recoil spring of the experimental pistol is shorter and lighter than the recoil spring of the caliber .45 pistol. The recoil spring plug and the recoil spring guide are slightly altered to fit the lighter recoil spring. The slide of the experimental pistol also differs from the caliber .45 pistol slide in that the extractor is attached to the rear of the barrel. The magazine is modified so as to hold seven cartridges, caliber .22.

The experimental pistol was found to be of the same inherent accuracy as the caliber .45 pistol in both slow and rapid fire, but due to the lessened mental hazard in firing the caliber .22 pistol, better scores were generally made with this weapon than with the caliber .45 pistol.

Army Air Corps Photo

Airplane View, Benicia Arsenal, Benicia, Calif.

Benicia Arsenal—Past and Present

Maj. C. E. Partridge, Ord. Dept., U. S. A.

THE Benicia Arsenal, the only active Ordnance establishment on the Pacific Coast, is located on Suisun Bay at the head of the Straits of Carquinez, on the outskirts of the city of Benicia, California, from which it derives its name.

The history of Benicia and of the arsenal is closely associated with the early American occupation of California. The land upon which the city was built was owned by General Vallejo, the Mexican General in command of the province. Two members of the party of Americans who captured the General and the garrison at Sonoma at the beginning of the "Bear Flag Movement" in 1846 thought they saw at this point the site of the future metropolis of California. They therefore negotiated with the General for a section of the land and finally purchased it and laid out a city in 1847. The General stipulated that this city should be named in honor of his wife, Francesca Benicia Vallejo; so the city was first named Francesca. But, when Yerba Buena changed its name to San Francisco, the name of Francesca was changed to Benicia. The city is on deep water and, in the days of the "forty-niners," many of the vessels rounding the Horn landed their passengers here; and for some years the Pacific Mail Steamship Company had its docks here. In 1854 the city was the capital of the State.

Arsenal Building erected in 1859, Benicia Arsenal.

The first military post was established here about 1848 on land that now comprises the northwest portion of the arsenal reservation. It was known as Benicia Barracks. Here Gen. U. S. Grant was stationed at one time as a lieutenant. The barracks were occupied by line troops, mainly Cavalry, until the time of the Spanish-American War. All troops were taken away at the beginning of that war and never returned. Recently the barracks area has been made a part of the Arsenal and all government land is now under one control. Most of the old buildings, formerly occupied as barracks and quarters, have been torn down, including the house once occupied by General Grant.

Late in the year 1850, Capt. C. P. Stone, Ordnance Corps, stationed at Fort Monroe Arsenal, was instructed to form a company of Ordnance enlisted men, proceed to California and establish an Ordnance Depot. The original of the following letter from the Chief of Ordnance to Captain Stone is still in the Arsenal files:

"Ordnance Department,
Washington, January 4, 1851.

"Brevet Captain C. P. Stone,
Fort Monroe Arsenal.

Sir:

"I have received your letter of the 2nd inst., reporting the progress made in your preparations for the voyage to California, and that you would probably be ready to sail by the 12th instant.

"Your duties in California will be, in general terms, the charge and supervision of all ordnance property in the Pacific Division, and of all business there, pertaining to the Ordnance Department.

"On your arrival you will report to the General commanding the Division; informing him of your means both in men and materials, and consulting him as to the best position for the establishment of an Ordnance Depot in California, and as to the proper arrangements to be made for supplying the Depot for Oregon, already established at Van Couver. Two Military Store-keepers of Ordnance will soon be ordered for duty in the Pacific Division, and in making your arrangements you can count on the aid of their services. You will keep this Department always informed of the ordnance stores or other means that may be required for completing or keeping in good order the armament of the Posts and Troops in that Division. I deem it unnecessary to give you more detailed instructions, as your own judgment and professional information will readily supply them.

"You are authorized to employ Mr. Trader agreeably to your request. Wishing you a pleasant and safe voyage, I am

"Respectfully,
Your obedient servant,
(Sgd.) G. TALBOTT, *Brevet Brig. Gen'l,*
Colonel of Ordnance."

Considering the day and age, the newness of the country, the distance from headquarters and the slow means of communication, it is evident that the Chief of Ordnance had unbounded confidence in Captain Stone's "judgment and professional information."

Captain Stone, with twenty-one enlisted men of the

Original Arsenal Buildings at Benicia, erected 1854.

Ordnance Corps, left Fort Monroe, Virginia, on board the Transport Ship Helen McGraw in the latter part of January, 1851, and, after rounding the Horn, arrived in California the latter part of July, 1851. After consulting with the General commanding the Pacific Division, it was decided to locate the Ordnance Depot at Benicia, and the California Ordnance Depot was established on the hills to the east of the Benicia Barracks, on land that is now the northern part of Benicia Arsenal. The name was changed to Benicia Arsenal in April, 1852.

At about this same time a Quartermaster Depot was also established at Benicia. This was located on the lower ground on the southern part of the reservation, near the Straits of Carquinez. One of the activities of the Quartermaster Depot was the maintenance of a herd of camels with which the government was experimenting as a means of transport. An old map shows the location of the camel corral to have been not far from the site of Building 71, the present-day tractor "corral" in which is kept, among other things, a "herd" of some eighty or ninety 5-ton tractors. After a few years the Quartermaster Depot was moved to San Francisco and the Ordnance Department took over control of the entire military reservation, with the exception of the Benicia Barracks. By 1860 the main part of the Arsenal had been established in this lower area, and all subsequent developments and additions have been in this area, the northern portion of the Arsenal grounds being utilized as a magazine area.

A perusal of old records and reports indicates that the Ordnance Department has held throughout the years to a reasonably uniform and consistent policy with reference to Benicia Arsenal. The old reports of the Chief of Ordnance generally referred to it as a "Depot of Deposit"—in other words, a storage and issue depot. It was always looked upon as an important establishment, the Chief of Ordnance frequently urging the importance and necessity of providing additional storage space and increased facilities for the repair of ordnance. Those in control of its destinies seldom, if ever, gave serious consideration to its development into a large scale manufacturing Arsenal.

From the time of its establishment until the period of the World War, its growth was slow but gradual. From time to time additional storehouses and shop buildings were erected and other improvements made.

Following are the names of the officers who have been in command of Benicia Arsenal:

Brevet Captain Charles P. Stone	1851-1856
Capt. Franklin D. Callender	1856-1860
Capt. Julian McAllister	1860-1864
Lieut. Col. Robert A. Wainwright	1864-1866
Col. Julian McAllister	1867-1886
Col. Silas Crispin	1886-1889
Maj. William A. Marye	1889-1890
Col. Lawrence S. Babbitt	1890-1899
Col. Alfred Mordecai	1899-1902
Lieut. Col. John E. Greer	1902-1903
Maj. Ira MacNutt	1903-1904
Maj. Frank E. Hobbs	1904-1905
Lieut. Col. James W. Benèt	1905-1911
Lieut. Col. Colden L.'H. Ruggles	1911-1913
Lieut. Col. John W. Joyes	1913-1915
Lieut. Col. Herman W. Schull	1915-1917
Col. Frank Baker	1917-1919
Col. Edward P. O'Hern	1919-1923
Maj. Thomas J. Smith	1923-1925

Col. Julian McAllister, who was in command from 1860 to 1864 and from 1867 to 1886, during what might be termed the formative period of the Arsenal, had much to do with making the Arsenal what it fundamentally is today. Many residents of the vicinity remember him well. Living here so long, he became closely identified with the life of the locality and, being so far away in time and distance from his superiors, he was his own boss to a remarkable degree. Benicia Arsenal might well have been his private estate.

Modern storehouses, shops in the background, Benicia Arsenal.

The Arsenal has always suffered from an inadequate supply of fresh water. There is no source of supply of fresh water within the Arsenal. The main reliance for potable water has been rain water caught and stored during the rainy season. Water for other purposes has been obtained for the most part from the Straits. The water in the Straits is salt for a considerable period of each year, and of late years, as more and more water has been withdrawn from the Sacramento River for irriga-

tion purposes, the annual period of fresh water has become shorter. Colonel McAllister apparently spent a large share of the twenty-odd years he was here in an endeavor to locate an adequate supply of potable water. He started one of the first deep artesian wells to be bored on the Pacific Coast. The boring of this covered a period of over ten years, the work being interrupted on numerous occasions for a year or more at a time by the failure of Congress to appropriate funds for continuing the work. The following extracts from his reports to the Chief of Ordnance on this project show the disappointments he experienced and the handicaps under which he worked through lack of necessary funds for promptly completing the work:

Surveillance Laboratory (1926)—the latest acquisition at Benicia.

"The present report is the 6th on this subject and the date of the last one, August 14, 1877, shows that two years have elapsed since I wrote you in reference to this matter, and the question whether the people of this coast, failing to secure surface water, can procure by boring, good artesian water, is still unanswered. This is a matter of great moment to all residents, manufacturers, rancheros, and even to the land speculators and financiers who reside here or who are interested in the prosperity of the States west of the Rocky Mountains. No person on this coast has yet obtained artesian water, nor has any individual or company bored to the depth which has been reached by the well at this Arsenal. An estimate of $6,707 was asked for in July, 1876, but Congress only appropriated $5,000.00."

And again:

"Money is the sinew of war, and it is certainly the muscle of work; the want of it can put a straight jacket on the best efforts and this deficiency which has been experienced, more especially toward the end of our work, will certainly cost the government something in the future."

From this it would appear that "economy" is no new watchword. The difficulty of which he complained was the freezing of the casing in the well during periods of suspended operations, resulting in great expense in freeing it when operations were resumed. The well was finally sunk to a depth of 1,407 feet. Both water and natural gas were obtained. The water was insufficient for the needs of the Arsenal and not potable. It was used for several years for irrigation and other similar purposes. The gas was obtained in relatively small quantities. It was utilized to save a part of the fuel burned under the boiler used in generating steam for operating the pump at the well.

California played an important part in the development and manufacture of powders for the Ordnance Department in the 90's. Among the powder companies in California which took an active interest in this work were the California Powder Works, The United States Powder Company, and The Giant Powder Company. All these companies displayed much interest and energy in an endeavor to develop and manufacture suitable smokeless powders for the Army. One of the smokeless powders developed and tested at about this time was a mixture of ammonium picrate and ammonium bichromate compressed into grains of various shapes and then graphited. It was stated in a report of 1895 that "the powder is not sensitive to shock, and being a mechanical mixture, will probably have much more stability than the gun cotton compounds." Several other mixtures of picrates were also tried out at this time.

A proving ground had been established at the Arsenal about 1882, and for a period of nearly 20 years this proving ground was very actively engaged in the test of powders for all calibers of cannon and small arms manufactured on the Pacific Coast, and also in the test of experimental samples of smokeless powders submitted by inventors in the vicinity.

During the period of the World War the Arsenal was engaged in supplying ordnance to the troops mobilized in the camps in the then Western Department and to the Siberian Expedition, as well as to the Hawaiian and Philippine Islands, and in the repair and overhaul of ordnance turned in by troops. Owing to its geographical location the Arsenal was affected in a small way only by the war as compared with the arsenals on the eastern seaboard, and did not experience the enormous increase in activities and expansion common to those arsenals. The maximum number of employees at any time during the war period was 245 as compared with 100 on April 6, 1917.

After the World War the Arsenal experienced a period of the greatest activity in its history. This was brought about through the demobilization of troops. The equip-

Receiving supplies from the East at the Benicia Arsenal Wharf.

ment and supplies turned in by these troops were sent to Benicia in large quantities. Storage space was totally inadequate for the housing of all this material. Furthermore, practically all of this equipment had to be cleaned, repaired and overhauled before being permanently stored in order to prevent deterioration in storage later. Realizing the necessity for increased storage space, a program of construction was inaugurated in 1919 providing for over 100,000 square feet of additional storage space, together with numerous facilities and other improvements.

AMONG THE CIVILIAN STAFF AT BENICIA
Standing: Antone Dutra, Magazine Keeper; Harrison Eversole, Master Armorer; John W. Caffrey, Master Mechanic.
Kneeling: R. L. Bowerman, Supt. of Storage; Robert H. Mann, Chief Clerk; and John P. Gieffels, Ordnance Provision Officer.

Today the Arsenal comprises 340 acres of land. It has storehouses for the storage of general supplies totaling 188,850 square feet of floor space, and magazines for the storage of ammunition and explosives totaling 21,325 square feet of floor space. The buildings as they exist today were erected from time to time during the past 75 years to meet varying needs and conditions. Many of the older storehouses are not well adapted to present conditions, either as to plan or location, for the efficient and economical methods of handling and storing supplies. There is a machine shop, smith shop, woodworking shop, small arms repair shop, optical repair shop and tractor repair shop. All of these shops are in general well and adequately equipped for performing the functions required of this Arsenal. There is a well equipped laboratory for the testing of powder and explosives in store at the Arsenal and at the several posts in the Ninth Corps Area. This laboratory is also utilized as a general chemical laboratory for the making of tests of materials purchased by the Arsenal. In addition there are various buildings of common utility, such as the office, officers' and non-commissioned officers' quarters, enlisted men's barracks, hospital, stables, garage and other buildings of minor importance. There is also about a mile of standard gage railroad track serving the principal storehouses and making direct connection with the main line of the Southern Pacific Railroad.

The normal quota of military personnel on duty at the Arsenal is three officers of the Ordnance Department, one surgeon, the 59th Ordnance Ammunition Company and the 80th Ordnance Depot Company. These two Ordnance Companies, together with the detachments of Medical, Quartermaster, and Signal Corps men make a total of approximately 75 enlisted men.

The number of civilian employees varies from about 65 to 85, averaging throughout the year about 75. These employees comprise mechanics of nearly all kinds engaged in the inspection and repair of ordnance and the maintenance of the buildings and facilities; storekeepers and others engaged in the receipt, storage and issue of ordnance matériel; and a clerical force engaged in accounting for funds and property, and other administrative duties.

The functions of the Arsenal are:

1. The storage and issue of ordnance matériel required by all components of the Army in the Ninth Corps Area and, to a limited extent, to Hawaii, the Philippines and the U. S. troops in China;

2. The storage of reserve matériel which would be required on the Pacific Coast in an emergency;

3. The overhaul and repair of ordnance rendered unserviceable through use by the troops in the Ninth Corps Area; and

4. A limited amount of manufacturing of supplies, mainly target materials and cast-iron projectiles used in target practice.

The Arsenal is in a fortunate position with regard to manufacturing target material. Due to the fact that practically all of the Southern Pacific Railroad from Benicia to Portland is Land Grant, lumber can be delivered to the Arsenal at almost mill prices, enabling the plant to produce target material and other like supplies at costs probably lower than any other ordnance establishment.

Aside from the relatively small quantities of ordnance manufactured at the Arsenal, all matériel stored and issued from Benicia comes from the eastern arsenals, being shipped by way of New York on Army Transports through the Panama Canal to San Francisco, from which point it is brought to the Arsenal dock by barge.

In recent years the Pacific Coast has made rapid strides in developing its capacity for the production of raw materials and manufactured articles, so that today it would be of very material assistance in providing the vast quantities of supplies which would be needed in the event of a major emergency. But it would not be self-supporting insofar as military equipment is concerned and would be dependent upon the manufactures of the East as its main source of such supplies. Being so far away from the center of gravity of the principal manufacturing area of the country, it is of the greatest importance that there be maintained on the West Coast at all times stocks of ordnance matériel in quantities fully adequate to meet the demands in the event of need, and Benicia Arsenal is ideally located as the storage point for these reserves.

Demand for space in this issue of Army Ordnance *made necessary the omission of the following articles previously announced for publication at this time: Part II of "Ordnance Budget and Fiscal System," by Maj. C. T. Harris, Jr., Ord. Dept., U. S. A., and Part II of the "Manufacture of Ordnance in Virginia During the American Revolution." Both will be published in the March-April issue.*

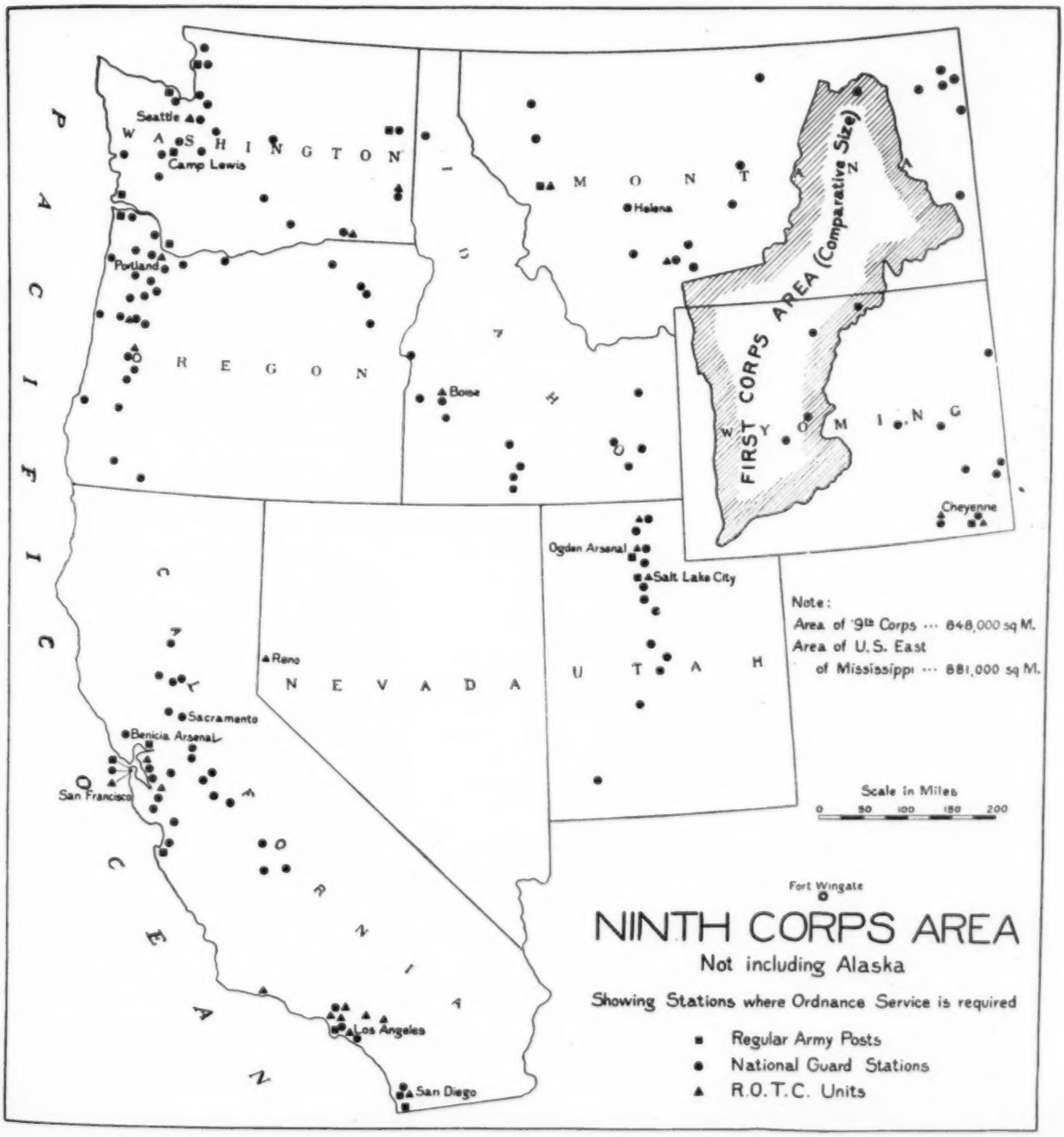
Ordnance Activities in the Ninth Corps Area

Maj. T. J. Hayes, Ord. Dept., U. S. A.

FOR the purposes of military administration, training, and tactical control the continental United States is divided into nine districts called Corps Areas. The Corps Area Commander, appointed from the list of Major Generals, is responsible for the administration of his Corps Area. He is assisted by a General Staff, consisting of a Chief of Staff and assistants. In addition to the General Staff there is the administrative, technical and supply staff.

The Corps Area Commander is responsible for the proper supply of ordnance material to troops within the Corps Area and for its alteration and maintenance. To the Corps Area Ordnance Officer, a member of the administrative, technical, and supply staff, is delegated this responsibility for the ordnance service of the Corps area.

The Ninth Corps Area is magnificent in extent. It includes all the states of the Pacific Coast, many of the mountain states and Alaska. Not including Alaska its area equals that of the entire United States east of the Mississippi River. The following comparisons are quoted to show the tremendous distances in traveling from one point



of the Corps Area to another over the shortest usually traveled routes as compared with journeys in other sections of the country:

Bellingham, Wash., to San Diego, Calif.	1,536 miles
Washington, D. C., to Wichita, Kansas	1,378 miles
San Diego, Calif., to Scobey, Mont.	2,462 miles
Washington, D. C., to Phoenix, Ariz.	2,572 miles

Throughout this empire the ordnance service must be extended to the organizations of the Regular Army, the units of the National Guard, to the Reserve Officers' Training Corps of universities and schools and to the Citizens Military Training Camps. Their artillery, their tanks, and tractors, their machine guns and rifles must be serviceable for training in peace, and more important, their matériel must be so maintained that it is always ready for the emergency of war. The office of the Ordnance Officer serves as an overhead for the field service of the Corps Area. At each Regular Army station there is a Post Ordnance Officer appointed from the line troops on duty at the station. This officer usually has other troop and staff duties to perform in addition to his ordnance duties. At Camp Lewis, on account of its size, and its many ordnance activities, an officer of the Ordnance Department is detailed as Camp Ordnance Officer. Non-commissioned officers and privates of the Ordnance Department and civilian armament machinists assist the post ordnance officers, and at Camp Lewis is stationed the Third Ordnance Company, assigned to the Third Division.

Dedication exercises of 14-inch R. R. Gun at Fort MacArthur, Los Angeles, Calif., after transcontinental trip from Aberdeen Proving Ground, Md.

Supply

One of the most important functions of the Corps Area Ordnance Officer is the supply of Ordnance matériel. Requisitions are initiated by organizations, approved by organization and higher commanders and forwarded to the Corps Area Ordnance Officer when supplies are not available locally. Here they are checked to see that allowances are not exceeded, that nomenclature is correct, and they are then sent to Benicia Arsenal, or in the case of special items, to one of the eastern arsenals, for filling. It is of great importance to the Corps Area to have Benicia Arsenal well stocked. Despite the air mail, the radio and the fast express, most business must be done by ordinary mail and transport service. San Francisco is three days away by mail from many of the army posts in the Corps Area and five from eastern arsenals. Add to this the difficulty of obtaining transport space from the East, the month or so it takes for handling and shipping by transport through the Panama Canal, and the dependency of the Pacific Coast on Benicia can be appreciated. The problem is very similar to that encountered by commercial distributing concerns, who to assure continuity of supply and quick service, maintain large storehouses of balanced stocks on the Coast.

Maintenance

With the requisitioned material supplied, the work of ordnance field service has only begun. This material must be constantly repaired and kept in good order. It is not enough to wait until material is reported defective or entirely unserviceable. The service must be aggressive. Needs must be foreseen insofar as possible and break downs prevented by timely inspection and repair. The Ordnance Officer, and his commissioned assistants and the armament and ammunition foremen, make an annual inspection of practically all the ordnance material of the area. The primary purpose of this inspection is not to find fault with personnel for the lack of care of material, but to see that their needs are supplied and that their material is ready for service in an emergency. The ideal way to inspect is to carry out necessary repair work at the same time. This takes away the bug-a-boo of inspection and accomplishes better understanding and cooperation. For instance, at the National Guard camps this year, where practicable, a detailed inspection of rifles, pistols, machine guns and other equipment was made. There was some opposition at first to having the annual inspection made at this period due to the fear that there would be interference with the training schedule. A program of inspection, however, was easily arranged so that there was no interference. A record of every defect with action to be taken was noted on blank forms prepared for the purpose, and copy of this furnished to the organization commanders so that they would know the exact status of their material. To hit the iron while hot, a small arms repair shop was established in a convenient place in camp with such personnel, enlisted and civilian, as were available. Front sights were tightened, damaged parts replaced, and faulty trigger pulls corrected. Assisted by company mechanics from the National Guard organization, practically all the defective equipment was repaired before the end of camp. Another accomplishment was the targeting of rifles whose bores were enlarged by wear but which were not yet so large that their unserviceability was certain. The firing was done by expert riflemen of the National Guard. It may be of interest to know that only some sixteen per cent. of the rifles whose serviceability was questioned showed that they were no longer serviceable for accurate fire. The troops were much interested in learning what constituted unserviceability and in having their defective material repaired. The attitude toward the inspection changed from a more or less hostile attitude at first to one of support and appreciation.

The maintenance, alteration and repair of material is continuous throughout the year. At the larger posts, especially those of the Coast Artillery, there are stationed civilian ordnance machinists immediately responsible to the local Ordnance Officers, but under the technical supervision of the corps area armament foreman. These machinists make necessary repairs, adjustments and new modifications that may be prescribed from time to time. For outlying posts, universities and schools where there are R. O. T. C. units, and National Guard armories, traveling machinists are used for the maintenance work. Material which cannot be repaired in the field is shipped to one of the arsenals, usually Benicia, for repair.

Since the war, the maintenance of ammunition has become of considerable importance. Supervising this work is the ammunition foreman, a man of mechanical experience who has been given special training along ammunition lines including the inspection of ammunition, its storage, and loading operations. With the serviceable life of ammunition manufactured during the war gradually coming to an end, constant watchfulness must be given to the stocks on hand, deterioration forseen and prevented where possible. One important phase of the work is the reloading and reconditioning of seacoast projectiles. It has been found that some projectiles loaded a number of years ago did not have a density of explosive sufficient to stand the shock of setback in the gun and of impact against armor. There resulted an unduly high percentage of duds. The reloading is being done by enlisted labor under the supervision of civilian foremen, former armament machinists specially trained for this work.

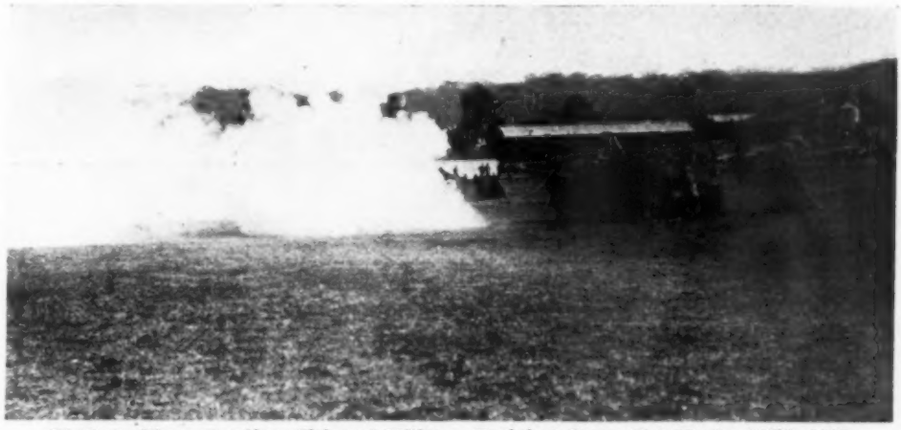
National Guard

As yet no ordnance companies of the National Guard have been formed in the Corps Area. The two National Guard divisions, the 40th and 41st, are rapidly being organized and it is hoped that before long at least the divisional maintenance company of the latter will be organized for service. At present the ordnance division of the Corps Area is principally concerned with supplying ordnance material and with its inspection and maintenance.

Organized Reserve

The status of organization of ordnance units of the Organized Reserve is progressing satisfactorily. Following are given the units organized, their home stations, and company commanders:

Unit	Home Station	Company Commander
437th Ord. Co. (M)	Oakland, Calif.	Capt. D. H. Atherton.
420th Ord. Co. (M)	Tacoma, Wash.	Capt. Kilian Schmitt.
829th Ord. Co. (D)	Los Angeles, Calif.	Capt. F. L. Hutsler.
389th Ord. Co. (M)	Berkeley, Calif.	Capt. John W. Brockhage.
629th Ord. Co. (A)	Oakland, Calif.	Capt. R. C. Waterman, Jr.
316th Ord. Co. (M)	San Francisco, Calif.	Capt. Arthur Brest.
329th Ord. Co. (M)	Great Falls, Mont.	Capt. Bernard Cain.
609th Ord. Co. (A)	Seattle, Wash.	Capt. H. A. Clark.
321st Ord. Co. (M)	Seattle, Wash.	Capt. W. C. Beasley.
359th Ord. Co. (M)	Berkeley, Calif.	Capt. W. C. Prichard.
509th Ord. Co. (HM)	Portland, Oregon	Capt. B. K. Postlethwaite.
398th Ord. Co. (M)	Portland, Oregon	Capt. G. F. Comstock.
399th Ord. Co. (M)	Los Angeles, Calif.	Capt. Ralph Handel.
404th Ord. Co. (M)	Stockton, Calif.	1st Lt. R. L. Baber.
535th Ord. Co. (HM)	San Francisco, Calif.	1st Lt. A. P. Buquor.
536th Ord. Co. (HM)	San Francisco, Calif.	Capt. E. L. Westlake.
646th Ord. Co. (A)	San Francisco, Calif.	1st Lt. A. J. Stevens.
638th Ord. Co. (A)	Los Angeles, Calif.	1st Lt. E. C. Williams.
808th Ord. Co. (D)	Fresno, Calif.	Capt. N. D. Vaughan.
809th Ord. Co. (D)	Eugene, Oregon	Capt. C. W. Aldridge.



Field Artillery Practice, Citizens' Military Training Camp, Del Monte, Calif., 1926.

In addition to the above, reserve officers have been assigned to the following organizations of the Regular Army:

3rd Ord. Co. (M)—Camp Lewis, Wash.
59th Ord. Co. (A)—Benicia Arsenal, Calif.
80th Ord. Co. (D)—Benicia Arsenal, Calif.

Corps Area Headquarters

The Corps Area Ordnance Officer has been made responsible for the training of all Organized Reserve Units except those assigned to the Divisions of the Organized Reserve. This year the training schedule during the active period was made with a view to training officers in their war-time assignments. A very successful camp was held at Rockwell Field for the 399th Ordnance Company (Maintenance), whose war-time assignment is with the Air Corps. The uses of aerial armament, its inspection, and repair were studied. This company was trained at the same time as a number of Air Corps organizations. This afforded an excellent opportunity for the ordnance officers to become acquainted with the officers with whom they would be associated in time of war and to understand their problems and methods of operation. At Fort MacArthur near Los Angeles, a reserve regiment of railroad artillery was having its annual encampment. The 437th Ordnance Company (Maintenance) is attached to this organization in time of war for maintaining its ordnance material. The personnel of the company was ordered to this camp so that they could become familiar with the new 14-inch railway gun matériel and with the operations of a railway artillery organization. The training of the 404th Ordnance Company (Maintenance) was held at Capitola, California, with the 63rd Coast Artillery Regiment (Antiaircraft), a Regular Army organization. This regiment is a motorized antiaircraft organization with 3-inch antiaircraft guns and machine guns. Attached to it is an ordnance artillery repair truck operated by a civilian ordnance machinist and enlisted personnel. The regiment is very progressive and

Organization and Function Chart, Ordnance Office, Ninth Corps Area

Corps Area Ordnance Officer

Assistant

- National Guard
  - (a) Instruction
  - (b) Inspection

Assistant

- Organized Reserves
  - (a) Personnel
  - (b) Training

Administration

1. *Executive*
   - (a) Coordination of office activities
   - (b) General periodic reports
   - (c) Publications and information
2. *Finance*
   - (a) Procurement authorities
   - (b) Allotment book
   - (c) Payrolls
   - (d) Time reports
   - (e) Vouchers
   - (f) Cost accounts
   - (g) Annual estimates
   - (h) Financial reports
3. *Property*
   - (a) Property records
   - (b) Surveys
   - (c) Sales
   - (d) Salvage
4. *Personnel*
   - (a) Military
   - (b) Civilian
   - (c) Records and reports
5. *Mail and Record*
   - (a) Correspondence file
   - (b) Suspended file

Supply

1. *Requisition*
   - (a) Regular Army
   - (b) National Guard
   - (c) R. O. T. C.
   - (d) C. M. T. C.
   - (e) Organized Reserves
   - (f) Miscellaneous
2. *Issue Costs*
   - (a) Transportation
   - (b) Packing and handling
   - (c) Reimbursement
3. *Records*
   - (a) Allowances
   - (b) Price lists
   - (c) Standard Nomenclature lists
   - (d) Shipping tickets
   - (e) Ordnance Bulletins
   - (f) Provision system

Armament

1. *Inspection*
2. *Maintenance*
3. *Alteration*
4. *Records*
   - (a) Drawings
   - (b) Pamphlets
   - (c) Specifications
   - (d) Texts of Revisions
   - (e) Work Orders
   - (f) Progress reports
5. *Technical information*

Ammunition

1. *Inspection*
2. *Maintenance*
3. *Surveillance*
4. *Requirements*
5. *Records*
   - (a) Drawings
   - (b) Pamphlets
   - (c) Specifications
   - (d) Texts of Revisions
   - (e) Work Orders
   - (f) Progress reports
6. *Technical information*

Statistical

1. *Material records*
2. *Mobilization*
   - (a) Annex
   - (b) Unit Plans
   - (c) Requirements
3. *Service reports*

carries on a heavy firing program. This made an excellent opportunity for the training of the Anti-aircraft Maintenance Company. The other maintenance companies were trained at Benicia Arsenal and Camp Lewis, and the ammunition and depot companies at Benicia Arsenal.

Mounting 75-mm. Sub-caliber Gun on 14-inch R. R. Carriage at Port McArthur, Los Angeles, Calif., August, 1926.

For training reserve officers while on inactive duty, main reliance is placed on the correspondence courses. The ordnance officers are scattered over such a large area that it is generally impossible to gather them together for group instruction. The one exception to this is in San Francisco, where there is a sufficient number to make training by the group method possible. Monthly meetings are held in the office of the San Francisco Ordnance District for officers living in the vicinity of San Francisco. The subject chosen for this winter is "General Information on Ammunition." The correspondence course in this subject is closely followed, but is made more instructive and interesting by exhibition of material, demonstrations, charts and photographs. This course was selected as being better adapted to instruction by conference than by correspondence. Credit for passing the correspondence course will be given. This will carry with it exemption from promotion examination in this subject.

It is of fundamental importance that every officer assigned to a company should know the mission of the company to which he is assigned. He should know which position he fills in the table of organization and what he does on mobilization. He should know the material his company will be called on to maintain. He should know when and where his company mobilizes, and what provision is made for giving intensive training to a few selected men prior to mobilization. To make certain that every company officer obtains this information a "Company Book" has been prepared for each company and given to the company commander. When practicable the officers of each company meet and study this book. When this is impracticable, it is mailed to each officer in turn. The following material is included:

Company roster with assignment of officers;

Organization and duties, including mission, equipment, training, line of command and matériel of organization to which assigned;

Pertinent army regulations and training regulations;
Table of organization;
Unit mobilization plan.

Finances

Maintenance and alteration for the Regular Army is financed by means of procurement authorities received from the Chief of Ordnance by the Corps Area Ordnance Officer. These procurement authorities authorize the Ordnance Officer to procure supplies and services for the purpose stated up to a certain amount specified. In special cases the Corps Area Ordnance Officer makes sub-authorizations to procure supplies and services to post and camp ordnance officers. Ordinarily, however, procurement of services and supplies is made directly by the Corps Area Ordnance Officer. Ordnance procurement for the National Guard, R. O. T. C., etc., for supplies that require reimbursement, and for maintenance, is made by the Corps Area Ordnance Officer under procurement authority given to the Corps Area. Work orders are issued for the work to be performed at posts and stations and reports submitted as to the labor and materials expended. Cost records are maintained in sufficient detail to form the basis for, and to support, the estimates of, funds submitted each year for the operations of the next year.

War Activities

On outbreak of war, the ordnance activities of the Corps Area are greatly increased. The peace-time functions continue, multiplied many times. In addition the Regular Army and National Guard regiments and other units must be expanded to full war strength. A few reserve units are organized in the first phases of mobilization. All these must receive the equipment required for their full war strength. And later in the following phases of mobilization the other units must be supplied with their weapons, their equipment and ammunition. A tremendous quantity of war material is involved. To meet these demands, war plans are being developed so that forces mobilized will receive their required ordnance material when and where needed and with the minimum amount of confusion. The present plans call for the decentralization of supply by designating certain supply points, four for the Corps Area, from which nearby organizations will be equipped. Schedules of deliveries with date and location required are being prepared for organizations, both for their preliminary training and for their equipment in preparation for entry into the theater of operations. To man this increased organization both at Corps Area Headquarters and at the supply points there are being assigned officers of the Ordnance Reserve selected for their fitness for the particular duties required in the war organization, to whom special training will be given.

Ordnance Reserve Officer Personnel

On the following pages are listed the names and addresses of Ordnance Reserve Officers who reside within the territorial limits of the 9th Corps Area. In publishing their names it is desired to add that their patriotic interest in matters of ordnance preparedness is keenly appreciated not only by the Commanding General and staff of the 9th Corps Area but by all citizens interested in the national defense.

Ordnance Reserve Officers, Ninth Corps Area

CALIFORNIA:

Branch Assignment:

*Major Walter H. Adams, Ord. Res.
823 Harvard Ave., Burbank, Calif.

2nd Lt. Harry V. Anderson, Ord. Res.
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*2nd Lt. Lawrence A. Anderson, Ord. Res.
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Maj. Emmett F. Annis, Ord. Res.
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*Capt. Arthur N. Armitage, Ord. Res.
550 E. Twelfth St., Pittsburg, Calif.

1st Lt. Herbert M. Bennett, Ord. Res.
1432 Carlos Ave., Burlingame, Calif.

*Capt. George R. Bliss, Ord. Res.
Carpinteria, Calif.

*2nd Lt. Franklin C. Blocksom, Ord. Res.
2535 Hillegas Ave., Berkeley, Calif.

2nd Lt. Walter M. Branch, Ord. Res.
The Coco-Cola Co., Los Angeles, Calif.

2nd Lt. Sam W. Burke, Ord. Res.
3640 W. 59th St., Los Angeles, Calif.

2nd Lt. Ralph N. Campbell, Ord. Res.
1312 E. Broadway, Long Beach, Calif.

2nd Lt. Carl V. Carlson, Ord. Res.
℅ U. S. Vet. Bur., 883 Market St., San Francisco, Cal.

*Capt. Harry B. Carr, Ord. Res.
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*2nd Lt. Frank W. Chambers, Ord. Res.
2136 Oregon St., Berkeley, Calif.

2nd Lt. Harold S. Christopher, Ord. Res.
607 W. 1st St., Los Angeles, Calif.

*Capt. Helmer W. Christensen, Ord. Res.
Llewellyn Iron Works, Los Angeles, Calif.

Capt. Richard J. Clark, Ord. Res.
3145 Kellog St., Point Loma, Calif.

*Maj. Almon W. Copley, Ord. Res.
1205 Drake Ave., Burlingame, Calif.

*Col. Bruce Cornwall, Ord. Res.
58 Sutter St., San Francisco, Calif.

*Capt. Joseph W. Criglar, Ord. Res.
1165 Bay St., San Francisco, Calif.

1st Lt. Horace H. Crow, Ord. Res.
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*Capt. William A. Doble, Jr., Ord. Res.
97 Tunnel Road, Berkeley, Calif.

*Capt. Arthur B. Domonoske, Ord. Res.
1144 Alameda St., Berkeley, Calif.

2nd Lt. Christian H. Early, Ord. Res.
80th Ord. Co., Benicia Arsenal, Calif.

*Maj. Everett J. Ellis, Ord. Res.
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*Capt. William R. Faweett, Ord. Res.
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*Capt. Dozier Finley, Ord. Res.
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*1st Lt. George E. Frahm, Ord. Res.
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*1st Lt. Boynton M. Green, Ord. Res.
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*Capt. William W. Harris, Jr., Ord. Res.
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*Capt. Clarence C. Harshman, Ord. Res.
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*Maj. Albert A. Hedge, Ord. Res.
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San Francisco, Calif.

*Capt. Harry O. Holt, Ord. Res.
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*Lt. Col. Theodore J. Hoover, Ord. Res.
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Associated, California.

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Benicia Arsenal, Benicia, Calif.

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*Maj. Earle T. Robinson, Ord. Res.
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*Capt. William E. Robinson, Ord. Res.
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*Col. David C. Seagrave, Ord. Res.
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*Capt. Frederick G. Tickell, Ord. Res.
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*Maj. Leon C. Van Bever, Ord. Res.
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*1st Lt. Howard P. Witten, Ord. Res.
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*2nd Lt. Robert R. Wyker, Ord. Res.
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Tech. Sgt., Ord. Dept., Hq. 9th C. A.
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2nd Lt. William A. F. Millinger, Ord. Res.
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2nd Lt. Walker K. Smith, Ord. Res.
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1st Lt. Edward C. Starr, Ord. Res.
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*2nd Lt. Roy C. Troeger, Ord. Res.
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649 So. Olive St., Los Angeles, Calif.

*2nd Lt. Clarence E. Vendley, Ord. Res.
964½ So. Serrano Ave., Los Angeles, Calif.

Capt. Norman D. Vaughan, Ord. Res.
care First National Bank, Fresno, Calif.

*Capt. Richard C. Waterman, Jr., Ord. Res.
143 Clinton St., Redwood City, Calif.

2nd Lt. Julian H. Weissbein, Ord. Res.
Hobart Bldg., San Francisco, Calif.

Capt. Earle L. Westlake, Ord. Res.
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2nd Lt. George D. Wickman, Ord. Res.
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1802 Claus Spreckles Bldg., San Francisco, Calif.

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IDAHO:

Territorial Assignment:

2nd Lt. Merlin G. Batley, Ord. Res.
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1st Lt. Newton O. Clemenson, Ord. Res.
Mackay, Idaho.

2nd Lt. William H. Thompson, Ord. Res.
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MONTANA:

Branch Assignment:

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Blackstone Apts., Great Falls, Montana.

2nd Lt. Lyman H. Hart, Ord. Res.
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*Lt. Col. Earle B. Norris, Ord. Res.
719 6th Ave., So. Bozeman, Montana.

Territorial Assignment:

1st Lt. Harry L. Short, Ord. Res.
Box 1825, Great Falls, Montana.

NEVADA:

Territorial Assignment:

Capt. Robert A. Allen, Ord. Res.
care State Eng., Carson City, Nevada.

2nd Lt. James E. Arkell, Ord. Res.
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*Capt. George W. Ridgway, Ord. Res.
P. O. Box 278, Reno, Nevada.

*Lt. Col. James G. Scrugham, Ord. Res.
Executive Chamber, Carson City, Nevada.

OREGON:

Branch Assignment:

2nd Lt. Charles R. Currier, Ord. Res.
1120 Board of Trade, Portland, Oregon.

Capt. Joseph A. Denn, Ord. Res.
231 No. Main St., Roseburg, Oregon.

1st Lt. William E. Milne, Ord. Res.
University of Oregon, Eugene, Oregon.

Maj. Samuel Powell, Ord. Res.
524 Oregon Bldg., Portland, Oregon.

Maj. Ambrose E. Ridenour, Ord. Res.
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Territorial Assignment:

2nd Lt. Edwin H. Albrecht, Ord. Res.
1309 Northwestern Bank Bldg., Portland, Oregon.

2nd Lt. William P. Allyn, Ord. Res.
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1st Lt. Charles O. Chatterton, Ord. Res.
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2nd Lt. Byron O. Garrett, Ord. Res.
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Capt. John Kearney, Ord. Res.
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*Maj. Roy R. Knox, Ord. Res.
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2nd Lt. Archie P. Rutherford, Ord. Res.
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2nd Lt. Alvin F. Sersanous, Ord. Res.
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2nd Lt. Herbert H. Sichel, Ord. Res.
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1st Lt. Carl Y. Tengwald, Ord. Res.
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UTAH:

Branch Assignment:

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*Capt. John McDonald, Ord. Res.
Ogden Arsenal, Utah.

Maj. Alfred E. Perkins, Ord. Res.
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Territorial Assignment:

*Capt. Bernard Cain, Ord. Res.
R. F. D. No. 1, Farmington, Utah.

2nd Lt. Michael J. Caragher, Ord. Res.
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2nd Lt. Navin H. McKay, Ord. Res.
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2nd Lt. Anton Remaitis, Ord. Res.
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2nd Lt. Gilbert W. Wegner, Ord. Res.
Tooele, Utah.

*Member, Army Ordnance Association, as of January 15, 1927.

WASHINGTON:

Branch Assignment:

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8602 12th Ave., N. E., Seattle, Wash.

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Capt. George F. Comstock, Ord. Res.
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Capt. Fred L. Dean, Ord. Res.
Hq. 3rd Div., Camp Lewis, Wash.

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New Army Supply Wagon

BEANS, "Cornwillie," and "Hardtack," those three inseparable companions of the doughboy will enjoy the privilege of being eased over undulating roads on springs, if the new Army supply wagon recently tested by the Infantry Board at Fort Benning, Georgia, is adopted as standard.

The new wagon is adapted to use by all branches of the Army. It is built in one unit and is 150 pounds lighter than the present standard escort wagon. By widening the body and eliminating the flaring side boards of the present wagon, the new vehicle can be loaded with greater ease and the capacity of the body is increased by 18 cubic feet. The size of all wheels is reduced to the dimensions of the commercial freight-carrying animal drawn vehicles. This allows greater ease in procurement. Its construction permits the front wheels to cut under the body and decreases the turning radius, in comparison to the present standard, from 12 to 7 feet. The prairie schooner type top is replaced by one in which the bows come straight up rounded only at the top corners. A viser is provided to come out over the front seat to protect the driver from the elements. The brake shoe is of such shape and manufacture that it can be cut with an ordinary saw from materials found along the road side, and this expedient eliminates the necessity of carrying the manufactured article.

The new wagon shows the influence of automotive developments. Rear springs are added to lessen the severity of the jolts. A foot brake will permit the driver to use both hands in the control of his four mule team. Grease holes in the hubs, through which grease may be forced by the use of a grease gun, obviate the necessity of removing the wheels when lubricating the axles.

Exhaustive tests over poor roads and across country for the past two years indicate that this experimental wagon will carry loads weighing 4,500 pounds drawn either by animals or by a tractor.

Ordnance Activities at Camp Lewis, Washington

1st Lieut. J. W. Freeman, Ord. Dept., U. S. A.

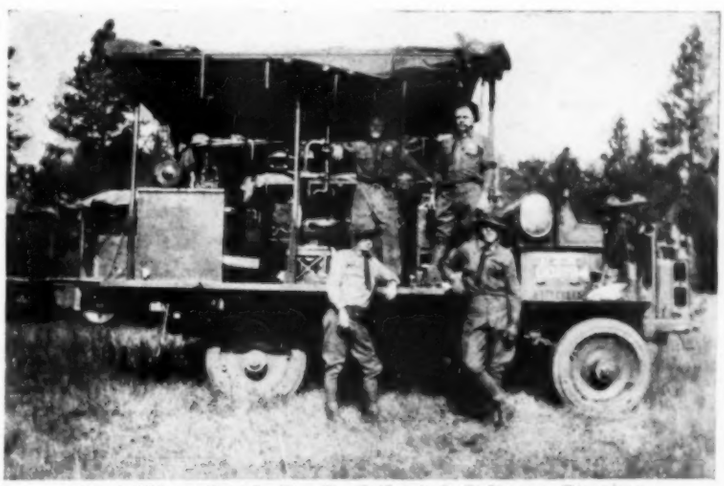
CAMP LEWIS Military Reservation has been used for years by the Regular Army and National Guard summer encampments. It is favorably known on account of the excellent opportunities for simulating field service, such as are apt to be encountered in actual warfare; there are open plains, heavily wooded areas, hills, running streams and lakes, in fact, a place may be easily found suitable for any sort of a military problem. The gravelly nature of the soil makes the use of motor trucks feasible. A twelve-mile artillery range gives ample room for target practice. The wooded areas can be used for practicing the concealment of batteries. The hills afford a background for small arms firing. Airplanes, hydroplanes and lighter-than-air craft may safely operate from the open prairie or the lakes which are numerous throughout the hundred square mile area.

Trucks of the 3rd Ordnance Company (Maintenance), Camp Lewis.

The climate is ideal for training. The temperature varies from slightly below freezing to a maximum of ninety degrees. The average temperature throughout the year is from forty-five to sixty degrees. The average rainfall is thirty-five inches per annum, but due to the porous nature of the soil, the water disappears almost immediately.

The domestic water supply is adequate and for all practical purposes is absolutely pure. Sewerage is of permanent construction and is built to salt water.

The transportation facilities are most noteworthy, for while this camp is situated in what might appear, from a hurried glance at the map, to be in a rather isolated corner of the United States, it is as a matter of fact most central from points west of the Mississippi River. It is practically the terminal of six transcontinental railroads, the Canadian Pacific, Great Northern, Northern Pacific, Chicago, Milwaukee & St. Paul, Union Pacific and Southern Pacific. The largest ocean-going steamers dock at Tacoma, sixteen miles distant, and similar docks could be constructed within three miles of the present camp.



An Artillery Repair Truck of the 3rd Ordnance Company (Maintenance), Camp Lewis.

Camp Lewis is situated on the Pacific Highway, a paved roadway which connects Vancouver, B. C., with Tia Juana, Mexico.

The entire reservation, containing approximately seventy thousand acres, or one hundred square miles, was acquired by the Government without expense, as it was presented by Pierce County, after purchase by the issue of two million dollars of bonds voted for the purpose.

Though scenery may not possess any great military value it is, however, an asset. The camp is situated in a most beautiful country, Puget Sound on the west, and to the east, in full view, is the snow-clad Mt. Rainier, or Mt. Tacoma, over 14,000 feet above sea level. During the spring and summer months the reservation abounds in myriads of wild flowers, brilliant shrubbery and berries.

Located at Camp Lewis are the Headquarters, Third Division; Headquarters, Third Field Artillery Brigade. The camp is garrisoned by the Tenth Field Artillery, Sixth Engineers, Special Troops, Third Division, the Third Division Quartermaster Trains, with the necessary Medical, Finance, Signal, Quartermaster and Ordnance detachments.

The Ordnance personnel consists of two officers of the Ordnance Department; one Camp and Division Ordnance Officer, the other, Commanding Officer of the 3rd Ordnance Company, forty-two enlisted men of the 3rd Ordnance Company, and a small Ordnance detachment of six enlisted men.

The Third Ordnance Company is what is known as a "Maintenance Company," and is part of Special Troops, Third Division. The training schedule for the Company is somewhat as follows: Massed calis-

The 3rd Ordnance Company (Maintenance), Camp Lewis.

thenics with all companies of Special Troops for fifteen minutes, and close order drill of the Company for a fifteen to thirty minute period. The remainder of the morning is devoted to technical training in the Ordnance shop. The afternoons are devoted to the care and preservation of the Ordnance matériel in storage. Saturday morning is taken up with the weekly inspection of men, shops and quarters. The Company also stands one ceremony, such as evening parade or review, a week, with Special Troops. The monthly reviews and inspections held by the Camp Commander are also participated in by the Company. The Company does not operate a mess, but is messed with the Third Tank Company.

As the Ordnance Department is charged with the design, procurement, storage and issue of such articles and equipment as may be assigned to that Department, so it is charged also with the maintenance, repair and inspection of those articles and equipment. To accomplish this latter mission one Ordnance company, maintenance, is assigned to each Infantry division.

To perform this important function each maintenance company is divided into sections: namely, Headquarters and Supply Section, Artillery Section, Armory Section, Automotive Section and Service Section.

The Headquarters and Supply Section is charged with the administration of the company, such as messing, reports, returns, etc., as well as obtaining clothing and individual and organization equipment.

The Artillery Section is charged with the maintenance, repair and inspection of all artillery matériel in the hands of the division.

The Armory Section is charged with the maintenance, repair and inspection service of all small arms and machine guns of the division.

The Automotive Section is responsible for the maintenance, repair and inspection of the automotive equipment of the company, and also that of the light tank company.

The Service Section is, as its name implies, the backbone of the service rendered. It is charged with the manufacturing, fabricating and inspection of any part or parts needed by the other sections of the company. This section numbers among its personnel the toolmaker, welder, leatherworker, carpenter and machinist.

The function of the maintenance company is service, and might well be compared to the service stations maintained by the large automobile manufacturers throughout the country. One of the most important functions of the company, however, is its inspection service. As the division commander depends upon his ordnance officer for information as to the serviceability of the ordnance equipment in the division, it devolves upon the maintenance company to furnish the division ordnance officer the training personnel necessary to make such inspections as may be required. Each section of the company is furnished with the necessary tools and gages to accomplish its mission.

If it were not for the fact that there is in storage at Camp Lewis about three million dollars worth of Ordnance matériel life at camp would be very enjoyable. This property consists of the equipment of a heavy artillery brigade, the tools and equipment for a heavy maintenance company and numerous motor vehicles and small arms. One has only to read the provisions of Ordnance Field Service Bulletin No. 4 to discover what is expected. During the past year somewhere around 25,000 gun slings were cleaned, oiled and re-stored. Approximately 4,000 rifles were cleaned, inspected and again placed in storage. A 100 per cent. inventory was completed, and as this property is stored in about 35 buildings, an idea of the magnitude of this task can be obtained.

Each year the Camp and Division Ordnance Officer has issued to the R. O. T. C., and C. M. T. C. all the Ordnance matériel necessary for the functioning of those camps. During the small arms range practice a part of the Armory Section of the 3rd Ordnance Company with a small arms repair truck was stationed at the firing points to make the necessary repairs and replacement of parts. This past year the same service was rendered the Washington National Guard at its summer encampment.

During the summer seven Reserve Officers of the Ordnance Reserve were trained at Camp Lewis. The training was of the associate method. Each officer was required to actually take command of the 3rd Ordnance Company, and also to conduct the morning period of close order drill. Several overnight practice marches were participated in. The Company shop was established, shelter tents pitched, and meals prepared on the rolling kitchen. This was done after a march of approximately twenty miles. Special stress was placed in the selection of camp sites, sanitation in the field, and location of divisional Ordnance shops. Actual field conditions were simulated as far as practicable. All the company transportation and organization equipment was taken on the march.

Due to the hard work, sagacity and personality of Captains H. C. Minton and E. L. Ford, Jr., Ordnance Department, Camp Lewis has established an enviable record for Ordnance Field Service.

California Post Army Ordnance Association

Pliny E. Holt

IN December, 1920, Col. Bruce Cornwall, Ord. Res., called together a number of ex-Ordnance officers and others interested in the work of the Ordnance Department to consider "ways and means for creating and maintaining industrial preparedness for any future emergency." At this meeting it was decided "to form a local unit or district of the Army Ordnance Association," and committees were appointed to secure increased membership in the Army Ordnance Association and to direct the specific work of the local unit. In January, 1921, after an exchange of correspondence between Hon. Benediet Crowell, the President of the Army Ordnance Association, and Colonel Cornwall, the latter was authorized to form the San Francisco District of the Army Ordnance Association to include San Francisco and the adjacent territory. This organization was accordingly effected with Colonel Cornwall as Chairman and the first regular meeting was held on January 26, 1921.

PLINY E. HOLT,
President, California Post,
Army Ordnance Association.

The records of the subsequent meetings held during that year and correspondence with the Secretary of the Army Ordnance Association indicate that this district organization contemplated covering in an unofficial way the duties subsequently officially undertaken by the San Francisco Ordnance District and by the Officer in Charge of Ordnance Reserve Units in the Ninth Corps Area, that is, a survey of manufacturing facilities and their coordination for Ordnance manufacture; a continued study of Ordnance technical subjects for the purpose of keeping a trained Ordnance personnel; and the recruiting and training of reserve officers. A number of papers on technical Ordnance subjects was presented at the monthly luncheon meetings and plans were formulated for undertaking an industrial survey.

It is well to recall that at this time the Ordnance Department was fully occupied in its problems of salvage and demobilization. The various provisions of the National Defense Act affecting industrial preparedness and the Organized Reserves had not been placed in operation. During the year 1921, however, the Chief of Ordnance perfected his plans for re-establishment of the Ordnance district system including the creation of the new district for the Pacific Coast which during the war had been part of the St. Louis Ordnance District. The establishment of this district in the early part of 1923 with the appointment of Colonel Cornwall as district chief on January 23, 1923, placed the work of industrial survey officially in the hands of the Ordnance Department thus relieving the San Francisco District of the Army Ordnance Association of its self-appointed task in this field. In 1921 there was placed in operation the territorial military organization as modified in accordance with the terms of the National Defense Act and the various Ordnance units of the military establishment for field service were assigned to the Ninth Corps Area. Later the responsibility for recruiting and training the Ordnance reserve officers for duty with these Ordnance units on the Pacific Coast was placed definitely in the hands of the Corps Area Ordnance officer. At the present time this work is in the hands of a commissioned officer (Major S. P. Spalding, Ord. Dept., U. S. A.) of the regular Ordnance establishment whose sole duty is the recruiting, organization and training of the Ordnance units and the Reserve Officers therefor for field duty. Thus the Ordnance Department took over the functions of industrial survey, allocation of facilities and the maintenance of personal contact with the Ordnance reserve officers in this area which had been under contemplation by the organization committee of the Association as part of its functions. The provision for training periods for both the units assigned to the military organization and for the personnel of the San Francisco Ordnance District, and the establishment of a comprehensive correspondence course in Ordnance subjects, covers these respective fields very completely.

These developments in the post-war reorganization of Ordnance Department activities accordingly modified the original mission assigned to the local organizations of the Army Ordnance Association. Following the practice of similar organizations it was decided to designate the local organizations as "posts" of the parent association, and on October 17, 1923, at a luncheon at the Palace Hotel it was decided to organize the California Post of the Army Ordnance Association. Colonel Cornwall presided as chairman at this meeting and appointed an organization committee of which Col. C. N. Black was chairman. A charter was issued by the Army Ordnance Association on December 28, 1923, and the first election of officers was held in May, 1924. There were thirty-six charter members at the time of reorganization and this membership was increased to over fifty before the permanent organization was effected. This membership has grown steadily and at the present time there are eighty-eight, including twelve junior members, enrolled from among the student members of the Ordnance

units at the University of California and Stanford University. In carrying out the purposes of this organization as defined in its constitution the post has been active in supplementing the work of the San Francisco Ordnance District and the Ordnance reserves in the Corps Area.

Three years' experience in the affairs of the Post have demonstrated the soundness of the purposes and organization of the Army Ordnance Association and its local posts. The local organization plays a very definite role, as the unofficial supplement of the local activities of the Ordnance Department. It provides a common meeting ground for all Ordnance personnel; it serves as a medium for the distribution of information about the Ordnance Department and its activities and for useful professional information in the way of reprints on technical subjects, reports, etc. In all of its work it has received the most cordial support from the Army Ordnance Association.

Officers and Members,* California Post, A. O. A.

President, Col. Pliny E. Holt.

Vice-President, Col. C. N. Black.

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Editorial

Ordnance on the Pacific Coast

THIS issue of ARMY ORDNANCE speaks for itself. It is a "Pacific Coast" number and presents a thorough account of Ordnance activities in the far West. To many readers the accomplishments chronicled herein will be but a recording of facts with which they are, after a fashion, familiar. To others, who, we dare say, are in a majority, this record will be a revelation. For all, this number should be an authentic record of the great Ordnance work that is going on in the western states.

At the start we desire to pay tribute to the sterling ability and whole-hearted cooperation of Col. Bruce Cornwall, Ord. Res., Chief of the San Francisco Ordnance District. Under his guidance Ordnance has taken its rightful place of importance on the Pacific Coast. To him, more than to any one individual, may be attributed the epoch-making advancement in Ordnance preparedness in that section. But, as in all other movements of importance so in this, the cooperation of many—civilian industrialists, economists, educators, Regular and Reserve Ordnance officers—has contributed to the total. While we make no mention, by name, of the leaders in these fields, their names are writ large in the annals of Ordnance achievement on the Pacific Coast. They are known to the Ordnance preparedness confraternity throughout the land and their contributions to this important work will live long after the task is taken up by generations yet to come.

We take a great deal of pride in presenting this Pacific Coast number. To plagiarize an idea from one of the authors, too many of us have thought of the West Coast in terms of oil wells and motion pictures. Here is proof positive, were proof needed, of the vast strides that have been made by American industry of all categories in that great western empire. Here is ample evidence, were evidence rquired, that Ordnance advancement in the western states has gone hand in hand with the other great accomplishments of that area. To those patriotic individuals, and they are reckoned in the thousands, by reason of whose effort and interest this is so, will go the congratulation and thanks of friends of munitions preparedness everywhere.

The Tripp Board Report

GEN. GUY E. TRIPP and his associates on the Committee on Industrial Preparedness, National Association of Manufacturers, transacted a very encouraging and worthwhile piece of business in the presentation of their preliminary report, published in this issue of ARMY ORDNANCE.

The Tripp Board report goes straight to the fly in the ointment of our industrial preparedness plans. The huge task of bringing American industry into step cannot be accomplished and will not be accomplished unless there are people to help see that it is done. Twenty-four Regular Army officers throughout the country are trying to survey the entire field of industry with the result that progress—magnificent as it has been—is being made all too slowly. Not only that, but the imposition on our manufacturers who are only too anxious to cooperate is hampering the attainment of results. It is not fair to ask the manufacturer to take some of his best men from their jobs to help prepare a survey of his plant and help keep that survey current. But many manufacturers are doing just that and they appear to be glad to do it. For all that, it isn't fair.

The remedy lies, as the Tripp Board points out, in this:

> "That the Ordnance Department of the United States Army be progressively increased over a period of years, in order to provide personnel of a proper degree of permanency equipped with the vitally important knowledge of the design and manufacture of ordnance, necessary to permit present plans for Industrial Preparedness to be carried to a successful conclusion."

And coincident with that remedy goes the Board's recommendation that

> "legislation be secured permitting the placing of 'educational orders' with commercial manufacturers for the production of non-commercial articles of ordnance with due consideration for knowledge of the art acquired rather than as at present, upon a competitive basis as to price."

The Tripp Board has hit the nail on the head. For General Tripp the work of his board is another evidence of his tireless interest in Industrial Preparedness—an interest that seems to increase as the World War slips steadily into memory; for the National Association of Manufacturers it is prompt manifestation of its appreciation of the importance of adequate Industrial Preparedness, while for all of us who are heart and soul behind this movement it is a milestone on the road toward an important goal.

Indorsing the "Munitions Battalion," urging more personnel for carrying out present Industrial Preparedness plans to a successful conclusion, and recommending "educational orders" with commercial manufacturers for limited production of ordnance in peace time—this is a great piece of constructive work. The Tripp Board is right in step. With the Morrow Board of yester year it stands head and shoulders above any concerted civilian cooperation in a long while.

Let's Have a Program

THE Chief of Ordnance does well to emphasize in his annual report the need for a program of ordnance manufacture. It is all very well for the Ordnance Department to continue to develop matériel. Proving ground and limited service tests go a long way toward ironing out the kinks, but final satisfactory development, as General Williams points out, is dependent upon manufacture of new types of matériel by Government establishments and industrial manufacturers in quantities sufficient to enable more general test by organizations in the field.

The logic of such a plea is incontrovertible. Suffice it to suggest that our large industrial organizations put in the vanguard of importance this very phase of their work. It is not enough to make a new machine fool proof in the laboratory. After testing it under every conceivable condition it is generally found that when the product is put in the hands of the user it is submitted to trials that were not conceivable in the development stages and up bobs a situation not previously calculated on.

Ordnance is no exception. As exact as the engineering requirements may have been specified, as precise as the design may have been evolved, as careful as the manufacturing requirements may have been followed, the unexpected arises when the product goes into the hands of the user who wants service and who cares little for reasons "why" the piece does not function. To cite a homely, but none the less apt simile: If one's radio balks when a feature broadcast is on the air, there is little consolation in having an expert, after profound thought, advise that the wiring diagram of the receiving set is faulty. When serviceable ordnance is needed feature broadcasts of a far more serious nature are on the air, or should we say, in the wind.

The importance of a *program* of *limited* rearmament of the Army with improved types of ordnance during a definite period of time is business-like, economical and necessary.

General Williams states the matter in his usual clear-headed way when he says:

"In my annual report for 1925 I reviewed some of the general principles underlying the program of development of new types of ordnance and the vital relation that the test of these new types in quantities sufficient to enable test by organizations bears to their final satisfactory development. I noted in this respect the importance of a program of limited rearmament with the improved types in the next 10-year period. Without repeating them these remarks of last year are again emphasized.

"Upon approval of the 10-year program in principle by the War Department, I prepared a schedule of manufacture under which each type of material would be manufactured not only in Government establishments but also by one or more industrial establishments. Manufacture of ordnance in an emergency can, of course, be best conducted by those who have had experience in its manufacture in time of peace, and I consider it most important that as many industrial firms as possible undertake orders for manufacture of moderate quantities of ordnance and thus acquire information which would be of the greatest value in the conduct of war manufacture.

"Manufacture in this manner also provides the best means of insuring that the new types proposed meet the requirements of manufacture on a production basis and that technical errors in the design of parts or in the specifications may be actually corrected in practice. The schedule of manufacture referred to was approved by the Assistant Secretary of War and will be put into effect when funds are secured for the manufacture of such limited quantities of material."

Nathan Hazen

MR. NATHAN HAZEN, an account of whose retirement from the Chief Clerkship of the Office of the Chief of Ordnance after 49 years of public service appeared in the September-October, 1926, issue of this journal, died December 29, 1926.

In the passing of this esteemed gentleman the Army and the Army Ordnance Association have lost one of those unsung heroes who give their very best in youth, maturity and even old age to the public welfare. He typified a class who contribute unstintingly of their talents to the every day duties of our great Government establishments. Their recompense lies not in the plaudits of the people who get to know only those whose leadership brings fame, but in the eminent satisfaction of a task well done.

To have so acted on the stage of life is ample warranty of one's right to "wrap the drapery of his couch about him and lie down to pleasant dreams."

Springfields vs. Broomsticks

COL. HANFORD MACNIDER, Assistant Secretary of War, is hard to beat at pleading the cause for Industrial Preparedness. At Providence, R. I., recently, upon the occasion of a meeting of the Military Order of Foreign Wars, he put his case, in part, this way:

"We hear a great deal about the necessity of training men for military leadership in possible emergency. These men were trained in the Reserve Corps, the Reserve Officers' Training Corps and the Citizens' Military Training Camps. They will not be of much use if they are forced to march out to the nation's defense armed with broomsticks. It happens that because we had a war we have rifles—Enfields, such as they are, ten years old—but ammunition ten years old is as dangerous to the shooter as to the 'shootee.' What is more, our supply of small arms ammunition would not last three months. It takes nearly a year to get into quantity production. That is, we must win at once, or those rifles had better be broomsticks. They would not be so hard to carry, and they would be just as useful. * * * *

"We have cannon—'seventy-fives' left from the war. New ones already developed shoot nearly twice as far and as effectively. Why haven't we any? We have, six. Have we ammunition? Perhaps a few months' supply, all nearly ten years old. How long to get into quantity production to make those guns useful? Ten months, at least. * * * *

"We have the wholehearted cooperation of industry, which realizes the importance of planning as national insurance. On articles which are not commercial, however, we must start from scratch. Take Ordnance, for example. No manufacturer is building 75-mm. shells in times of peace, or anything that resembles them. It will take nearly a year even with the most painstaking advance planning to get into high on delivery of the finished article.

"War reserves must be set up and maintained, if there is to be any semblance of national protection. We cannot buy time once the emergency is upon us.

"Our Ordnance Department and the other Services of Supply are made up of able men. With limited means they have put up a good fight to maintain their part of the defense structure. Their activities are not as picturesque as those of the combat branches. For that very reason, they need your interest, help and backing in Congress to a greater degree than those spectacular military activities already sold through their traditional gallantry in action—by the printed page, the silver screen, or from the bunting-draped platform on National holidays."

Professional

Annual Report of Maj. Gen. C. C. Williams, Chief of Ordnance, U. S. Army

THE annual report of Maj. Gen. C. C. Williams, Chief of Ordnance, made public by the War Department November 23, 1926, outlines the experimental work of the year, ranging from tanks that travel 16 miles an hour across country to 14-inch guns mounted on railway cars. The report, addressed to the Secretary of War, also urges that funds for the replacement of deteriorating ammunition be increased.

General Williams recommends that when such funds are secured, orders for ordnance materials be placed in small quantities with civilian manufacturers who in time of war would be called upon to convert their whole plants to the manufacture of combat material. The plan, he points out, will enable the manufacturers to work out problems of design and technique which can be solved more easily in time of peace than in the rush of war manufacture.

The full text of the official summary of the report as prepared by the War Department follows:

"The average number of civilian employes in the office of the Chief of Ordnance during the year was 228, as compared with 242 for the preceding year. The number of employes in the field was increased from 4,143 for the year 1925, to 4,529 for the year 1926. The total number of employes has been reduced from 60,237 at the time of the Armistice to 4,757 on June 30, 1926.

Mobilization

"The system of mobilization planning described in my last report has been in operation over one year. It is believed that the results have proved its value. Many defects and deficiencies have been uncovered and corrected. Closer liaison with the General Staff and the Office of the Assistant Secretary of War has been maintained. Responsibilities for operation have been more clearly defined, and all of the various subdivisions of the Ordnance Office have become more familiar with the mobilization plan and their operation under the plan.

"Recently an advisory committee on war plans, consisting of the Chief of Ordnance and the chiefs of the major subdivisions of the Ordnance Office, has been established. This committee considers policies, outlines directives, and analyzes the progress which is being made in mobilization plans.

"Procurement planning for the requirements set up by the general mobilization plan is progressing satisfactorily.

"The contact obtained with industry through our procurement districts is doing much to help simplify the Ordnance tax of production in time of war. Civilian engineers are studying our problems. New methods of production are being proposed and tested out. Valuable suggestions with respect to specifications and designs are being received, and in many other ways this contact is proving very helpful.

"One interesting outcome of this contact with civilian industry is the development of manufacture of projectiles from seamless tubing. Projectiles of 75-mm. caliber have been produced and successfully tested. The successful development of this method of producing projectiles will tremendously increase production possibilities and decrease the time necessary to produce in quantity.

Preparedness Advanced

"The important matter of factory plans for war production has received a decided impetus during the past year. A great many of the largest and most responsible manufacturers are detailing one or more of their engineers to study our needs and make detailed factory plans for their production.

"The supervision and coordination exercised over procurement planning by the Office of the Assistant Secretary of War has been of great assistance.

"Detailed unit plans for the distribution of supplies under the general mobilization plan continue to lag behind other plans, due to delays in receiving the corps area mobilization requirements. These requirements have, however, now all been received, with two exceptions, and as soon as these can be consolidated and analyzed, and allocations made to field establishments, it will be possible to perfect these unit supply plans.

"In the appropriations for the fiscal year 1927, there are carried for the first time funds for the building up of deficits in the war reserves of ammunition. Preliminary estimates for the fiscal year 1928 carry funds for the building up of one-twentieth of the deficits in accordance with the announced War Department policy. These preliminary estimates also carry funds for replacing in the reserve ammunition which is expended for annual training.

Deterioration Increasing

"The building up of a small portion of the deficit each year, and the replacement of ammunition consumed in target practice will do much toward maintaining an adequate reserve. This, however, is not sufficient. The amounts of loaded ammunition that are lost annually through deterioration are steadily increasing, and it is essential that steps be taken in the near future to replace more rapidly this deteriorated ammunition.

"In my annual report for 1925, I reviewed some of the general principles underlying the program of development of new types of ordnance and the vital relation that the test of these new types in quantities sufficient to enable test by organizations bears to their final satisfactory development. I noted in this respect the importance of a program of limited rearmament with the improved types in

the next 10-year period. Without repeating them, these remarks of last year are again emphasized.

"Upon approval of the 10-year program in principle by the War Department, I prepared a schedule of manufacture under which each type of material would be manufactured not only in Government establishments but also by one or more industrial establishments. Manufacture of ordnance in an emergency can, of course, be best conducted by those who have had experience in its manufacture in time of peace, and I consider it most important that as many industrial firms as possible undertake orders for manufacture of moderate quantities of ordnance and thus acquire information which would be of the greatest value in the conduct of war manufacture.

STANDARD TYPES SOUGHT

"Manufacture in this manner also provides the best means of insuring that the new types proposed meet the requirements of manufacture on a production basis and that technical errors in the design of parts or in the specifications may be actually corrected in practice. The schedule of manufacture referred to was approved by the Assistant Secretary of War and will be put into effect when funds are secured for the manufacture of such limited quantities of material.

"In general, the latest approved types of material submitted for consideration to the interested services have been favorably considered and it is important the final adoption as standards should be effected in order that intelligent planning can be made for the production of such improved types in quantities when actually required.

"It must, of course, be accepted that material of the types now on hand will be very largely used in any future emergency, but it is also true that an urgent demand will immediately arise for new improved types that can be supplied and the importance of making adequate plans for the supply of such improved types as well as of existing types is obvious.

"Development of 37-mm. gun, and 75-mm. mortar material, for use by the Infantry, continued during the past year. This material included the 37-mm. Infantry gun, model of 1925-E; the 75-mm. Infantry mortar, model of 1924; and the Infantry cart, model of 1925. Tests of this material at the Aberdeen Proving Ground have shown that it is satisfactory mechanically and tests by the Infantry Board at Fort Benning indicate that it apparently fulfills the requirements of the service. Two additional units of both the gun and mortar, and four additional carts, are now under manufacture.

EARLY ISSUE EXPECTED

"It is expected that this material will be issued for service test early in the ensuing fiscal year. Studies have been inaugurated to investigate methods of transporting this material on pack animals. This has been found to be practicable with the mortar, after a few minor changes. The packing of the 37-mm. gun material, model of 1925-E, however, upon animals has been temporarily abandoned. It has been decided to make the necessary changes on the 37-mm. gun material, model of 1916, to enable it to be packed on animals in cases where this method of transportation is desired.

"The 75-mm. gun matériel, model of 1923-E, has been tested by the Field Artillery Board, and, following favorable reports and recommendations by the Chief of Field Artillery, this matériel has, during the past year, been adopted by the War Department as a standard for manufacture. The adoption as a standard for manufacture of this 75-mm. split-trail carriage does not preclude the standardization at some later date of a box-trail 75-mm. gun carriage, in case tests should indicate such action to be desirable. It is quite likely that our Book of Standards will eventually show as standards for manufacture both a split-trail and a box-trail 75-mm. gun carriage.

"The first series of tests of the 4.7 inch gun matériel, model of 1921-E, has been completed by the Field Artillery Board, which board submitted a very favorable report thereon to the Chief of Field Artillery. Certain minor modifications, however, appear to be necessary, and it is planned to incorporate these changes in the pilot vehicle, after which it will be resubmitted to the Field Artillery Board for such further tests as may be considered desirable.

155-MM. HOWITZER, MODEL 1920

"Tests of the 155-mm. howitzer matériel, model of 1920, have been completed by the Field Artillery Board at Fort Bragg, and reports on this matériel have been submitted. As a result of the study of available tractors for hauling this matériel, the board concluded that it was undesirable to subdivide this unit so that it could be transported by two 5-ton tractors and recommended that this matériel be hauled as a single load by a 10-ton tractor. Accordingly, all studies of a transport wagon for this matériel have been abandoned for the time being.

"The experimental carriage for mounting, interchangeably, either the 155-mm. gun or the 8-inch howitzer, has been thoroughly tested by the Field Artillery Board, whose reports on this carriage is generally favorable. Certain modifications have been recommended which will be incorporated in the pilot as soon as practicable, after which the carriage will be resubmitted to the Field Artillery Board for further test.

"The design and manufacture of a high-powered 105-mm. antiaircraft fixed mount was undertaken during the year. Due to the weight of the round of ammunition (67 pounds), it was found necessary to provide this mount with an automatic loading device, in order that a high rate of fire might be maintained. Manufacture of the gun, carriage and sighting system has been completed, and the unit will be tested at the Aberdeen Proving Ground during the present fiscal year.

SOUND LOCATORS IMPROVED

"Eighteen sound locators, exponential horn type, T1, under manufacture during the fiscal year 1925, were completed early in the fiscal year 1926, and have been issued to six regular antiaircraft regiments. An improvement of the exponential sound locator has been developed, the new type being designated as T2. Two of these have been completed.

"The Bureau of Standards has cooperated with the Ordnance Department during the year in an attempt to increase the range and directivity of the sound locator and has developed a condenser transmitter for use with the exponential horn. Radio amplifiers were used to increase range and directivity. The new equipment will be tested during the summer of 1926.

"The pilot 14-inch gun railway mount, model of 1920, upon completion of its proof firing at the Aberdeen Proving Ground, was shipped, in October, 1925, on its own wheels, to the Pacific Coast. This unusual trip of such a large railway mount was accomplished without undue difficulty. Recently, this mount was successfully emplaced at Fort McArthur, California, on an all-around fire emplacement.

"A second mount of this type is now practically completed and undergoing shop test at the Watertown Arsenal. Two additional mounts are nearing completion. The appropriations for the fiscal year 1927 include funds for trucks of five-foot gage for two of these mounts, in order to make them suitable for use on the railroad in Panama. It is anticipated that the modification of these trucks will be completed within the year.

Tank Experiments

"Design and development work on tanks during the year has been principally on the medium 25-ton tank; although some preliminary study work has been done on the light tank. The test of the original pilots 1921 and 1922 medium tanks has continued, including the test of the new Packard engine, and two types of clutches which will later go in the third medium tank produced, which is well under way at the Rock Island Arsenal. The test of this new engine in the model of 1921 tank will be in the nature of a preliminary test of the engine and clutches, and possibly other equipment to go into the new pilot.

"A high-speed test of the medium tank, model of 1922, was conducted which demonstrated that it is possible to operate this tank across country at speeds up to sixteen miles an hour. Although this test resulted in considerable damage to the engine, it proved that the transmission and other mechanisms in the power train are capable of carrying the load, and it is believed that with a proper power plant high speeds are feasible.

"The service test of the 'Caterpillar 30' tractor progressed to a point where the Chief of Field Artillery recommended its adoption as a standard medium tractor, and the necessary steps to complete standardization of this vehicle have been taken. It will be shown as the standard medium tractor in the next revision of the Book of Standards, and the five-ton tractor, model of 1917, which was formerly standard, will be carried as a substitute.

'Caterpillar 60' Approved

"The 'Caterpillar 60' test was completed, and the Chief of Field Artillery recommended that it be standardized as the heavy military tractor. After being cleared for procurement by the Assistant Secretary of War, the Adjutant General approved it as to type as the standard heavy tractor, to replace the ten-ton, model 1917, tractor. When revised, the Book of Standards will show the 'Caterpillar 60' as the standard, and the ten-ton, model 1917, as the substitute heavy tractor.

"Instructions were received from the War Department to determine what changes are required in the Artillery repair truck, model of 1918, to render it suitable for use as a light machine shop truck for all services. Correspondence and conferences with the various branches indicated that this vehicle is practically satisfactory in its present form. It was recommended by the Ordnance Office as the standard for all branches, and was so adopted by the War Department."

Annual Report of Rear Adm. C. C. Bloch, Chief, Bureau of Ordnance, U. S. Navy

EXTRACTS from the annual report of Rear Admiral C. C. Bloch, Chief, Bureau of Ordnance, U. S. Navy for the fiscal year ended June 30, 1926, are published below. The complete report was released by the Navy Department during December, 1926.

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Development and Research

"6. During the past year development and research work has been conducted actively, most of the work being accomplished through the Naval Proving Ground, Naval Powder Factory, Naval Gun Factory, Naval Torpedo Station, Newport, and the Naval Research Laboratory, the Chemical Warfare Service, Bureau of Mines, and the Bureau of Standards being of assistance in cases involving the use of special facilities and personnel under these agencies.

"7. Experimental developments during the year have included work directed toward the improvement of propellant powders, high explosives, projectiles, torpedoes, mines, aircraft bombs, other aircraft devices, fuzes for projectiles, fuzes for bombs, smoke-producing materials, pyrotechnics, and optical instruments.

"8. Work of development is necessarily slow and in many cases it takes years to complete a single development; however, steady, systematic, and painstaking effort causes the completion of a few developments each year.

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Fleet Improvements

"14. During the year the regunning program planned has been carried out. New antiaircraft batteries have been installed on the *Maryland*, *Colorado*, and *West Virginia*. These batteries promise to be a great improvement over any others in service, and the bureau confidently expects greatly improved efficiency in antiaircraft defense.

"15. A design of air-blowing head for torpedoes has been satisfactorily placed in manufacture, and a number of these devices has been issued to service. This device ejects the water from the exercise head of the torpedo at the completion of the run and causes the torpedo to float high and vertically, thus making its visibility much greater. By means of this device it is hoped that losses of torpedoes will be greatly reduced.

"16. There is a pressing demand in the fleet for adequate range finders for destroyers. New range finders for destroyers will be supplied as funds become available.

"17. By cooperation with the Bureau of Navigation, a gyro-compass equipment is being supplied with transmission identical to that used in the fire-control systems; this eliminates the necessity of relays and increases the flexibility and efficiency of the fire-control system.

"18. A periscope target has been designed to be used for target practices. A number of these targets has been made, and they have functioned satisfactorily. This target is released from a submerged position, rises to the surface, where it remains exposed for a short period of time, and then slowly sinks.

"19. A number of .22-caliber Springfield rifles has been obtained and the entire number has been issued to the service. These have proven to be a valuable means of training and greater efficiency in small-arms firing is expected.

"20. As a result of experimentation which has been underway at the Naval Gun Factory since the *Mississippi* accident, certain modifications have been made to gas-ejecting systems to improve the efficiency of these systems. New nozzles have been installed and the plans for increasing the capacity for compressed air on all battleships have been worked out. On six ships steps are now being taken for supplying additional high pressure air banks, and as opportunity offers necessary steps will be taken on other ships.

"21. In some cases it has been found that a piece of unconsumed powder bag has been found in the bore of a gun after firing. This material in one case was smoldering and without careful inspection of the bore a subsequent charge of powder might have been loaded into the gun with some danger of preignition. In order to avoid such occurrences, it was the idea of technical experts that an automatic mechanical device, to be called a nebulizer, might be designed and installed for the purpose of injecting into the powder chamber and bore after each shot a sufficient quantity of finely atomized water which would act to extinguish any burning particles. The design of the nebulizer was completed and one of these appliances built. Its mechanical action was so good as to leave nothing desired. This nebulizer was installed on a 14-inch gun and tried out during routine firing at the naval proving ground. The device operated at the naval proving ground as desired, however, the water injected tended to collect at the bottom and rear end of the powder chamber to such an extent that it appeared that the succeeding powder charges were being wet to such an extent as to interfere with the prompt ignition of the successive round. Of course, such a result is undesirable and the object of the nebulizer, while accomplished, would be accomplished at the expense of efficiency in serving the battery. Further tests will be made with the nebulizer to definitely establish whether or not such a device can be satisfactorily applied to naval guns.

"22. A universal bomb and torpedo truck has been designed for handling such material on board ship and at shore stations. In this design, commercial axles, wheels, and tires have been utilized in construction in order to cheapen the cost and facilitate replacements.

"23. Powder-impulse catapults are being installed on battleships as completed. Reports indicate that these catapults are very efficient in performance and are a great improvement over the air-impulse type.

"24. The hearty cooperation of the fleet with the bureau in connection with matters of design, operation, and supply has been of the greatest assistance, and the bureau believes that as a result thereof greater efficiency exists than ever before.

SHORE ESTABLISHMENT

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STANDARDIZATION OF SPEED GEAR OILS

"34. During the past year, extensive tests of speed gear oils have been made for the purpose of obtaining data to be used in the preparation of standard specifications for speed gear oils. As a results of these tests, it has been found practicable to use oils meeting the specifications and tests for force feed and motor cylinder oils, light. This class of oils is covered by yearly Navy Department contract and can be obtained at numerous points on both coasts at a saving in cost over oils previously purchased.

SPECIFICATIONS

"35. Much has been accomplished during the past year in connection with revision and preparation of Navy Department and Federal specifications. The Bureaus of Engineering, Construction and Repair, and Ordnance have been engaged in the revision of specifications for electric auxiliaries used on board naval vessels for the purpose of making specifications mentioned conform as nearly as possible to the requirements of the Electrical Power Club and the American Institute of Electrical Engineers.

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NAVAL POWDER FACTORY

"40. During the year the following manufactures have been made at the naval powder factory:

	Pounds.
Ether	567,000
Sulphuric acid	2,756,000
Nitric acid	991,000
Pyrocellulose	970,000
New powder	1,026,000
Reworked powder	535,000

"41. In addition to the above there was manufactured and shipped to other plants and stations the following:

Pig zinc (salvaged)	212,000 pounds
Niter cake	185 tons

"42. There have been no fires or casualties during the year.

"43. The chemical laboratory has made 7,000 complete analyzes during the year in addition to the manufacture of necessary test paper required in the service.

"44. Experimental and special work has included surveillance of various explosives under atmospheric and varying temperature conditions, analyses of special explosives, black powder, tetryl, TNT, fulminate of mercury, test of 3-inch illuminating mixtures, investigation of exudate from TNT, research connected with reclaimed TNT, investigation of possibility of ignition of black and smokeless powder by friction, using various materials, test of cartridge-bag cloth, investigation of effect of exposure to moisture on the functioning of primers, investigation of abnormal powders from service, investigation of kinds of ink to best withstand powder fumes, analyses of projectile paints, clay putty, perchlorates, chlorine putty, silver solder, gun deposit, centralite, aluminum alloys, special investigations of the purification of diphenylamine, freezing points of acid mixtures, standardization of various solutions and apparatus, and the manufacture of fulminate of mercury.

"45. Every effort is being made at the naval powder factory to reduce the cost of its product. Personnel is being reduced as low as is consistent with safe and economical operation.

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NAVAL PROVING GROUND

"48. During the year 5,064 rounds were fired at the naval proving ground, the total amount of powder expended amounting to slightly over 300,000 pounds. The above includes all proof work and experimental work connected with the service of the fleet.

NAVAL ORDNANCE PLANT, SOUTH CHARLESTON, W. VA.

"49. This plant has been inoperative during the year; it is the effort of the bureau to keep the plant and installation in proper state of preservation and in readiness for starting up on 30 days' notice.

"50. The moneys received from rent at this plant, which are turned into the Treasury, exceed the amounts expended for the maintenance of the plant.

NAVAL ORDNANCE PLANT, BALDWIN, LONG ISLAND

"51. This plant has been operating during the past year, manufacturing illuminating projectiles for the service. The operations of the plant have been satisfactory.

NAVAL TORPEDO STATIONS

"52. The naval torpedo station, Alexandria, Va., has been inoperative and has been used only as a storage point for torpedoes. A small force of men has been employed there for the maintenance of torpedoes in storage.

"53. The naval torpedo station at Keyport, Wash., is used as a storage and repair plant. No torpedoes are manufactured at this place, the only work done being for the maintenance of torpedoes stored there and repair and upkeep of torpedoes of the fleet.

"54. The naval torpedo station, Newport, R. I., has been in operation during the entire year, engaged in the manufacture of torpedoes and manufacture of spare parts, repair of torpedoes, and experimental and research work.

"55. During the period July 1, 1925, to June 30, 1926, 57 officers completed the course in the Torpedo Officers' School; 240 enlisted men completed the course at the Torpedo Men's School. These schools are necessary for the satisfactory operation of torpedoes in service and should be maintained.

"56. Several hundred torpedoes have been fired on the proof range during the year. No torpedoes have been lost at that place.

"57. The air detachment has been of great assistance at Newport, not only for experimental work but also for observing torpedoes fired and for searching for lost torpedoes. A total of 309 flights was made during the past year.

NAVY MINE DEPOT, YORKTOWN, VA.

"58. This point is used as a storage point for mines and high explosives. The maintenance of the material on hand at that place has been made satisfactorily.

NAVAL AMMUNITION DEPOTS

"59. These ammunition depots are located at various points contiguous to the ports used by the fleet. Their mission is to supply ammunition when required to the fleet and to receive ammunition from the fleet when it is necessary to remove it. The work at ammunition depots was satisfactory during the year; however, shortly after the close of the fiscal year a disastrous explosion occurred at the naval ammunition depot at Lake Denmark, N. J.

"60. Until 1890 the main ammunition depot for the east coast of the United States was located at Ellis Island in New York Harbor; in this year, the Treasury Department requested the removal of the ammunition depot in order that the island might be used for an immigration station. At that time the munitions stored there were removed to Fort Wadsworth until a new site could be obtained by the Navy. The act of Congress of April 11, 1890, appropriated $75,000 for the purpose of purchasing a new site and for erecting necessary buildings. After examining a number of locations, it was finally determined that the best available site was at Dover, N. J., and accordingly preliminaries were instituted for the transfer of a tract of land at that place which belonged to the United States Government and was being used by the Army. It was considered that the position was well adapted for ordnance purposes. In 1891 a magazine, a shell house, and three small cottages were being erected. The Navy Department always considered the development of Lake Denmark as being necessary as it was intended that this place should be the main depot on the east coast. At subsequent dates other buildings were erected.

"61. In 1902, 75 acres of land were purchased. In 1918, 64 additional acres were purchased. During the World War, in order to provide storage for the enormous quantities of material being purchased, a large number of buildings was built at Lake Denmark.

"62. On July 10, 1926, there was a severe electrical storm at Lake Denmark and about 5:15 P. M. there were several lightning crashes within the ammunition depot or near the southwest end thereof. Immediately after these crashes black smoke was seen issuing from the northeast corner of temporary magazine No. 8. A fire alarm was turned in at once, personnel of the station responded, and at least one stream of water was turned on the fire. At 5:20 P. M. a detonation occurred at the scene of the fire and a second detonation occurred about 5:25 P. M.

"63. The detonations did great damage, by causing roofs to collapse, walls to be broken in, doors being crushed in many other shell houses and magazines to which fire was almost immediately communicated, thus causing fires in nearly all of the buildings on the station.

"64. All of the buildings at Lake Denmark were protected against lightning.

"65. About 35 buildings were untouched by fire, however, in nearly every case their walls, their roofs, windows, and doors were severely damaged.

"66. The casualties in dead were as follows: Navy personnel, commissioned 3, enlisted 1; Army personnel, commissioned 1; Marine Corps personnel, commissioned 1, enlisted 11; civilians 2. No person outside the reservation, except the Army officer referred to above, was fatally injured. The two civilians were on the station at the time of the accident.

"67. Over half in value of the material stored at Lake Denmark is uninjured and can be salvaged. The present plan is to repair about 30 buildings and to store as much material in these buildings as can be accommodated, and, at a later date, when it is known how much additional material will have to be cared for, erect temporary buildings to accommodate this material.

"68. Immediately after the disaster, a court of inquiry was appointed to inquire into all matters relating thereto. The court of inquiry has submitted its report and made the following recommendations:

"'1. That immediate consideration be given to the following points and early action taken:

(*a*) To segregating cast TNT in bombs, depth charges, mines, or other similar containers, from all other explosives or stores.

(*b*) To grounding of the metallic parts of magazines and their contents.

(*c*) To instructing magazine personnel to avoid fighting heavy fires in high-explosive magazines.

(*d*) To making magazines, shell houses, and containers as noninflammable as practicable, and of such construction as to eliminate forming heavy missiles in case of explosion.

(*e*) To locating dwellings clear of probable injury by fire explosions.

(*f*) To supplying ammunition depots with improved fire alarm and fire-fighting equipment, and additional roads to provide access to fires.

(*g*) To making distances between magazines adequate in future construction; and to preparing a table of distances to serve as a future guide, having in mind possible use of barricades or subsurface stowage.

"'2. That the naval ammunition depot at Lake Denmark be rebuilt as an ammunition depot to accommodate such quantities of explosives as may be safely stored there, after a development plan has been approved by the Navy Department.

"'3. That Congress be asked at its next session to provide for two ammunition depots for the storage of high explosives. One of these depots to be within a radius of 1,000 miles from the Pacific coast and to be so located as to have convenient railroad facilities to the Los Angeles-San Diego area, to the San Francisco Bay area, and to the Columbia River-Puget Sound area, the land provided to be either Government-owned or cheap barren land, covering an area of at least 100 square miles, and allowing an unoccupied safety zone of 2 miles; the other depot in the East, of a similar area, centrally located, so as to have convenient railroad transportation to the Atlantic and Gulf ports, and to our east coast naval magazines.'

"69. These recommendations will be carefully studied and the necessary action will be taken."

Secretary of War Submits Bill for "Educational Orders"

The Secretary of War, Hon. Dwight F. Davis, has submitted to the Committee on Military Affairs the draft of an amendment to the National Defense Act, approved June 3, 1916, which will authorize the Secretary of War to place "educational orders" for war materials with various industrial concerns throughout the country so that in the event of an emergency they will be acquainted with the technique of munitions manufacture needed in the successful prosecution of war.

The Secretary states, in his letter accompanying the draft, that this legislation is desired to further industrial preparedness for war. In the consideration of industrial preparedness he points out that modern war is a war of machines and requires these machines in numbers heretofore undreamed of.

The capacity of Government arsenals for the manufacture of armament is small compared with the amount required, and the industry of the country must make up this deficiency.

Modern industry is not familiar in time of peace with munitions manufacture. Without this familiarity valuable time is lost when an emergency arises. The placing of these orders will unquestionably add to national preparedness. This legislation has been discussed with the Director of the Budget and its submission is favored by him.

Contributors to this Issue

COL. BRUCE CORNWALL, Ord. Res., U. S. A., has served as Chief of the San Francisco Ordnance District since its organization in 1923. A lawyer by profession, he served as Major and Lieutenant Colonel in the Office of the Chief of Ordnance during the World War.

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MAJ. W. A. CAPRON, Ord. Dept., U. S. A., was, until recently, on duty at the San Leandro, Calif., plant of the Caterpillar Tractor Company. He is now stationed at the Aberdeen Proving Ground, Maryland.

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DEAN T. J. HOOVER has had wide engineering experience in Europe, Australia, Asia, Alaska and Mexico. In 1926 he was made Dean of the School of Engineering, Stanford University.

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LT. J. W. FREEMAN, Ord. Dept., U. S. A., is Commanding Officer of the 3rd Ordnance Company (Maintenance) at Camp Lewis, Wash.

MR. PLINY E. HOLT, President of the California Post, Army Ordnance Association, has been closely associated with the development of the commercial tractor. During the War he served in the Office of the Chief of Ordnance.

MAJ. ROGER SHERMAN HOAR, Ord. Res., U. S. A., is head of the Patent Department, Bucyrus Company, South Milwaukee, Wis. Following his World War service as instructor of advanced orientation at the Coast Artillery School, he became instructor in ballistics at the Ordnance School of Application. He resigned his commission in 1921.

Personnel

Philadelphia Post, A. O. A., Established

ON December 9, 1926, the Philadelphia Post of the Army Ordnance Association was officially launched after several months of preparatory work. Hon. Benedict Crowell, President of the Army Ordnance Association, conducted the installation ceremony and presented the charter to the new organization. He welcomed the new post into the national organization and in so doing spoke of the importance of having a post in the Philadelphia District, which is conceded to be one of the most important Ordnance areas in the country. He emphasized the distinct service to the nation which the Philadelphia Post could render by stimulating and maintaining interest in all matters pertaining to the Ordnance Department.

Mr. J. C. Jones, Chief of the Philadelphia Ordnance District, presided at the meeting as temporary chairman until the election of officers and Board of Directors was completed. The quarters of the new Army and Navy Club of Philadelphia, 313 South Broad Street, were used for this meeting.

Brig. Gen. C. L'H. Ruggles, Ord. Dept., U. S. A., Assistant to the Chief of Ordnance, spoke of the work being done in the various Ordnance Districts toward the peace-time organization of industry for war. He stressed the importance of industrial preparedness and illustrated how such preparedness at the outbreak of the last war would probably have prevented our being forced into it. The fact that we were not prepared, industrially or otherwise, caused Germany to underestimate our power and, consequently, force us into the war. He stated that travelers in Germany returning home invariably report that had the United States been adequately prepared she would never have been forced to fight.

Lack of munitions, stated General Ruggles, caused the long drawn out trench warfare on the western front during the last war. The terrible waste caused by this was given as the principal reason why adequate reserve stocks of munitions should be maintained at all times. There are two ways by which sufficient stocks of munitions may be had in time of war. The first is by the manufacture and storage of large stocks in times of peace. This method is very expensive and is both undesirable and impractical because of deterioration and changes in design which come with the passage of time.

The second method has to do with having our peace-time industries so organized and prepared that they can begin to manufacture extremely large quantities of munitions of all kinds on very short notice. It is the cheaper and more desirable method and it presents a field in which the Army Ordnance Association can be of inestimable assistance to the government.

General Ruggles brought out two fundamental facts which should strike home to every one who heard him. Current reports from the various Ordnance Districts indicate that, on the basis of present plans and potentialities, it will take from ten to twelve months for the maximum production of munitions to be achieved. General Summerall, the new Chief of Staff, who served throughout the last war, has made a very careful study of the problem of munitions in conjunction with any future emergency in which this country may be involved. He is of the opinion that the first six months of the next war in which the United States fights will be the most important. The issue is therefore clear. Maximum production of munitions *must* be obtained in a much shorter period than now seems possible.

Colonel Sorley, Chief of Staff of the 79th Division with headquarters in Philadelphia, presented the actual military side of the whole preparedness program. He explained the workings of the various reserve line organizations and commented on the enthusiasm of the commissioned personnel, but stated that under present conditions inducements for attracting enlisted reserve personnel were lacking. The purposes of the R. O. T. C. and the C. M. T. C. were explained and Colonel Sorley stated that instruction in teamwork was fundamental in both, together with a recognition of the rights and privileges of the other man. He asked for the cooperation of the manufacturers in the Philadelphia District by granting their employees leaves for military service of this kind.

Mr. Charles Z. Tryon presented a motion for the appointment of a committee to investigate the desirability of having the Philadelphia Post, in connection with other organizations, petition the War Department for the establishment of a reserve cavalry unit in the vicinity of Philadelphia. He stated that because of its well-known interest in all matters pertaining to the horse Philadelphia was a logical point for the establishment of such a unit. He particularly emphasized the wealth of trained equestrian personnel that could be drawn on for its formation. The temporary chairman referred the matter to the newly elected officers of the Post for consideration.

Major J. A. Steinmetz, Ordnance Reserve, a member of the Engineers' Club of Philadelphia, stated that that organization was very much back of the idea of a Philadelphia Post of the Army Ordnance Association. He presented for consideration an idea which has had the approval of many engineers who have been brought in contact with the industrial preparedness program of the United States. It was suggested that the Philadelphia Post prepare personnel records of all reserve officers and civilian members of the A. O. A. in the Philadelphia Ordnance District and record thereon at least once each six months the industrial experience and achievements of each member for whom a card is carried. The cards used should coincide as far as possible with the forms used by the Office of the Chief of Ordnance at Washington. The local records thus built up would

become a reservoir of experience data by which the Ordnance Office at Washington could be guided in making assignments to duty in the Philadelphia District in time of emergency. This matter also was referred to the newly elected officers.

A draft of the proposed Constitution of the Philadelphia Post of the Army Ordnance Association was read by Capt. F. C. Shaffer, Executive Assistant of the Philadelphia District Ordnance Office. It was unanimously adopted. The election of officers ensued, with the following results:

President: Maj. John Q. MacDonald, Ord. Dept., U. S. A.

Vice-President: Lt. Col. Archibald B. Hubard, Ord. Res., U. S. A.

Directors: Maj. Joseph A. Steinmetz, Ord. Res., U. S. A., Charles Z. Tryon, Samuel Shoemaker, Edward T. Longstreth, E. M. Chance, J. W. Robbins.

The Board of Directors went into immediate session and appointed Lt. T. R. Snyder, Ord. Res., U. S. A., as Secretary, and Capt. F. C. Shaffer, Ord. Dept., U. S. A., as Treasurer, in accordance with the provisions of the newly adopted constitution.

Plans for Pittsburgh Post, A. O. A.

THE Advisory Board of the Pittsburgh Ordnance District met November 11, 1926, in the Dravo Auditorium, 302 Penn Avenue, and reported progress made in that District by the major industrial plants.

Brig. Gen. C. L'H. Ruggles, Assistant to the Chief of Ordnance, represented the Assistant Secretary of War at this meeting, and outlined what the War Department expected from this District in the event of a national emergency.

Mr. Ralph M. Dravo, the District Chief, introduced the Advisory Board, which had been formed during the last year and also outlined the purpose of the meeting.

Capt. Fred A. McMahon, Ord. Dept., U. S. A., who is Executive Assistant to Mr. Dravo, prepared charts showing the organization of the District and explained the status of emergency orders placed with the different industrial plants in this District.

Mr. Homer Williams, President of the Pittsburgh Steel Company, who is Chairman of the Advisory Board, spoke on "The Seamless Tube Industry in Germany."

Mr. Taylor Allderdice, Vice-President of the National Tube Company, discussed the manufacture of 75-mm. and 155-mm. shell made from seamless tubing. His company manufactured experimentally, during the past year, a number of both calibers of shell. Samples of these shells were shown at the meeting.

Mr. Frank Bell, President of the Edgewater Steel Company, who is Assistant District Chief in charge of the Manufacturing Division, spoke on the "Manufacture of Guns from Seamless Tubing." Maj. G. Elkins Knable, of the Carnegie Steel Company, also gave suggestions on the manufacture of guns from seamless tubing.

Maj. K. F. Adamson, Ord. Dept., U. S. A., from the Office of the Chief of Ordnance, Washington, D. C., presented the requirements in the manufacture of guns, while Capt. H. F. Safford, Ord. Dept., U. S. A., from the same office, gave the requirements for all calibers of shells. Mr. A. L. Humphrey, President of the Westinghouse Airbrake Company, presented a paper on the "Factory War Plan," outlining in detail exactly what each manufacturing plant, with which emergency orders have been placed, should prepare in the way of a Factory War Plan.

Lt. Col. H. A. Gidney, who is also an Assistant District Chief, spoke on the "Organization of a Local Army Ordnance Post." A general discussion followed, in which great interest was shown as to the probability of manufacturing guns and shells from seamless tubing.

At the close of the meeting, Mr. Dravo, District Chief, thanked all present for the interest they have shown in preparing the country against any emergency, and hoped that they would continue to do so during the coming year. All present were then luncheon guests of the District Chief, Mr. Dravo. The following attended the meeting:

Homer D. Williams, Pittsburgh Steel Company;
William G. Clyde, Carnegie Steel Company;
A. L. Humphrey, Westinghouse Airbrake Company;
Taylor Allderdice, National Tube Company;
E. T. Whiter, Pennsylvania Railroad Company;
William L. Monro, American Window Glass Company;
A. W. Thompson, United Gas Improvement Co., Phila.;
Frank Bell, President Edgewater Steel Company;
T. M. Girdler, Jones & Laughlin Steel Corp.;
H. E. Field, Wheeling Mold & Foundry Co.;
O. W. Buenting, Union Switch & Signal Company;
D. Wyman, Wheeling Mold & Foundry Co.;
H. M. Reed, Standard Sanitary Mfg. Co.;
Thomas Fleming, Jr., Oilwell Supply Company;
H. J. Irwin, National Lead & Oil Company;
F. J. Kress, F. J. Kress Box Factory Company;
A. N. Diehl, Carnegie Steel Company;
James O. Carr, Allegheny Steel Company;
W. E. Ackerman, Wheeling Steel Company;
H. F. Wahr, Mesta Machine Company;

Brig. Gen. C. L'H. Ruggles, Col. Robt. M. Brambilla, Lt. Col. T. E. Durban, Lt. Col. H. A. Gidney, Lt. Col. W. M. Hogg, Lt. Col. G. P. McNiff.

Maj. P. W. Barr, Maj. J. A. Bell, Maj. W. W. Golden, Maj. G. W. Morrison, Maj. G. M. Sixsmith, Maj. Charles Yon, Maj. E. B. Danenhower, Maj. G. Elkins Knable, Maj. John A. Hallock, Maj. K. F. Adamson.

Capt. P. F. Guinther, Capt. R. E. Baker, Capt. W. W. Runyan, Capt. F. N. Sarber, Capt. Furman South, Jr., Capt. W. B. Hampton, Capt. J. F. Lyon, Capt. H. F. Safford, Capt. W. N. Thomas, Capt. W. J. Ungetheum, Capt. Fred. A. McMahon.

Lt. C. E. Sjogren, Lt. L. B. Armbrecht, Lt. P. F. Mumma, Lt. F. A. Hennigan, Lt. L. M. Wolford, Lt. John P. Dean.

Inaugural Meeting, St. Louis Post, A. O. A.

THE inaugural meeting of the St. Louis Post of the Army Ordnance Association will be held at the Coronado Hotel, that city, on the evening of January 18, 1927. Mr. M. E. Singleton, Chief of the St. Louis Ordnance District, will preside.

The speakers, in addition to Mr. Singleton, will be Hon. Benedict Crowell, President, A. O. A.; Brig. Gen. C. L'H. Ruggles, Ord. Dept., U. S. A., Assistant to the Chief of Ordnance; and Mr. Harry Scullin, President, Scullin Steel Company, St. Louis.

A complete account of the inaugural meeting will be published in the next issue of this journal.

Patents

Patent Rights of Government Employees

Maj. Roger Sherman Hoar, Ord. Res., U. S. A.

THE article by Mr. W. N. Roach on the above subject, in Vol. VII, No. 37, of ARMY ORDNANCE, should be supplemented by a quotation of Army Regulations 850-50, as amended by War Department Circular 26 of 1926.

The reason for the importance of doing so is that, in the first place, this material summarizes very neatly the law on the subject; and, in the second place, Army Regulations, when not inconsistent with Statute, have the full force of law with respect to men in the government service. (Act of March 1, 1875; *Gratiot* v. *United States*, 4 How. 80, 117.)

Before quoting the Regulations in question, I wish also to mention paragraph VIII of G. O. 31, W. D. 1924, which sets forth the patent clause prescribed for government contracts; and paragraph V of Bulletin 16, W. D. 1922, which establishes the Interdepartmental Patent Board.

Now to the text of A. R. 850-50, which reads as follows:

"1. Policy of the War Department.—The fixed policy of the War Department is to encourage invention among officers, warrant officers, enlisted men, and civilian employees under its jurisdiction.

"2. Rights in patents and inventions.—In the matter of patents for inventions, the relation of the Government toward its officers, warrant officers, enlisted men and civilian employees is the same as that of any corporate or other employer toward its employees. *Solomons* v. *United States* (137 U. S. 342).

"3. Exclusion from right to sue United States.—An officer, warrant officer, enlisted man, or civilian employee, however, may not sue the United States in the Court of Claims, or elsewhere, for the unauthorized use by the United States of his patented invention. (Act June 25, 1910 (36 Stat. 851), as amended by Act July 1, 1918 (40 Stat. 705).) These statutes also apply to any patented invention discovered or invented during the service of the officer, warrant officer, enlisted man or civilian employee, and used after his separation therefrom.

"4. Title to patents on inventions by War Department employees.—Where an officer, warrant officer, enlisted man, or civilian employee of the War Department is specifically designated or employed to invent a specific thing and does so at the expense of the Government, the title to the invention and to the patent obtained thereon becomes the property of the Government. If the invention is made in the course of the employment of such person on the time or at the expense of the Government, but not by direct designation or employment for that purpose, then the Government has an implied license to use the invention, but the title to the same and to the patent acquired thereon is the property of the inventor. In any other case, where there is no contract or term of employment providing otherwise, such inventor is the sole owner of the invention and of the patent acquired thereon, and no implied license accrues to the United States by reason of the inventor's employment. However, an inventor, while in the Government service, or his assignee, may not sue the United States in tort for infringement of a patent, nor may he so sue after quitting the Government service if the invention was made during such service, but Government inventors have the same right as other persons to sue the United States in the Court of Claims on contracts express or implied (Act June 25, 1910 (36 Stat. 851), as amended by Act July 1, 1918 (40 Stat. 705).) In any case the inventor promptly should take proper steps to have his invention covered by a patent, in order not only to protect his own interests but in proper cases those of the Government as well.

"5. Patents obtained without payment of fees.—When an invention of an officer, warrant officer, enlisted man, or civilian employee is used or to be used in the public service a patent may be obtained therefor without the payment of any fee, provided the applicant in his application shall state that the invention described therein, if patented, may be used by the Government or any of its officers or employees in the prosecution of work for the Government or by any other person in the United States without the payment to him of any royalty thereon. (Act March 3, 1883 (22 Stat. 625).) As the United States District Court for the Southern District of New York decided on September 3, 1924, in the case of Squier v. American Telephone and Telegraph Co. that the operation of the Act March 3, 1883, works a dedication of the invention concerned to the public, all War Department inventors are advised that the Patent Office fees should be paid in each case where the inventor desires to safeguard for himself the commercial value of his invention.

"6. Classes of inventions.—Inventions evolved by officers, warrant officers, enlisted men, and civilian employees fall broadly into three classes—

a. Those which do not refer to and are not evolved in the line of the duty of the officer, warrant officer, enlisted man, or civilian employee.

b. Those which arise in connection with and as a result of the officer's, warrant officer's, enlisted man's, or civilian employee's official duties.

c. Those which are produced as a result of a specific employment or contract to make an invention of the specific device or article.

With regard to the first class the War Department has no particular concern unless the invention has military value; and if so, will accept a nonexclusive license, if tendered. With regard to the second class the War Department requires at least a nonexclusive license in writing and in cases where the invention is important in the national defense may request a complete assignment. The War Department will assert the ownership of the Government in the third class and will require an assignment of the entire right, title, and interest therein."

(The amendment prescribed in War Department Circular 26 of 1926, referred to above states:

"All officers, warrant officers, enlisted men or civilian employees of the War Department who secure patents upon their inventions under any of the aforesaid circumstances where the inventor retains title to the patent and

the United States is licensed thereunder, are advised that full justice to the interests of the United States as licensee under the patent or patents concerned should prompt them to notify the War Department of any further licenses or assignments they may make of their patent interests to the end that contracting officers of the Government may at all times be informed thereof.")

"7. Doubtful cases to be referred to The Adjutant General.—When in the application of these regulations any doubt arises as to any question concerning inventions or patents, the matter, with a complete statement of facts, will be submitted to The Adjutant General, for decision by the Secretary of War."

All the foregoing is, however, more or less academic, in view of the fact that the only redress of a Government employee, whose patented invention has been appropriated by the Government, is to sue in the Court of Claims under the Act of June 25, 1910, chapter 423, as amended by the Act of July 1, 1918, chapter 114; and this Act contains the following important limitation:

> "That the benefits of this Act shall not inure to any patentee who, when he makes such claim, is in the employment or service of the Government of the United States, or the assignee of any such patentee; nor shall this Act apply to any device discovered or invented by such employee during the time of his employment or service."

This proviso was construed in the case of Moore v. United States, 249 U. S. 487, which case interprets the Act to mean what it says, namely, that an inventor cannot sue the Government under a patent, the subject matter of which was invented while he was an employee of the Government.

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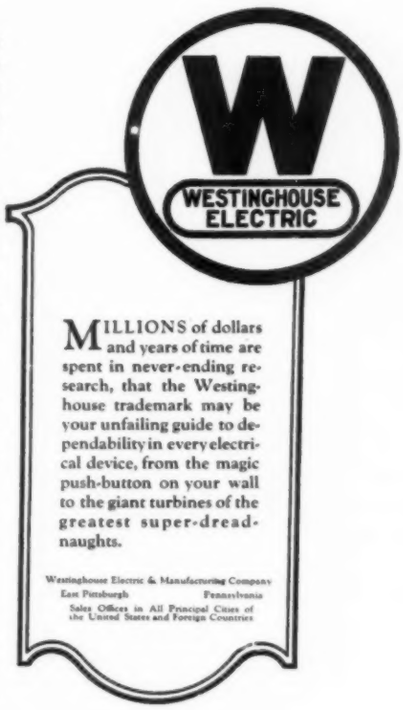

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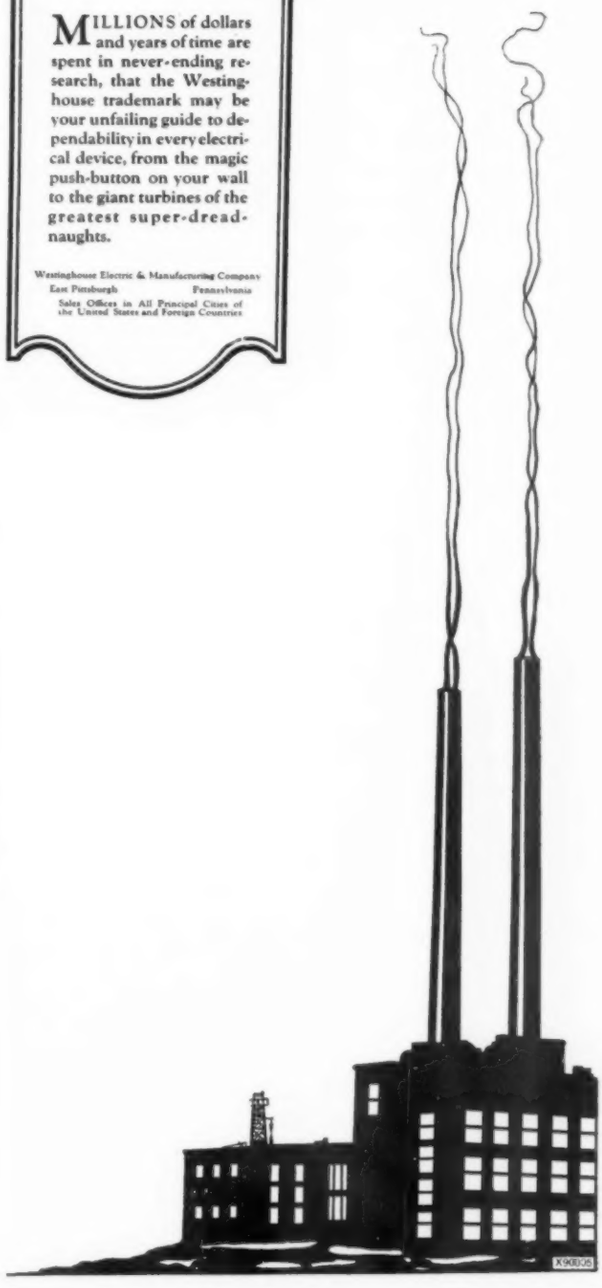

Books

Allenby of Armageddon. By Raymond Savage. Indianapolis: The Bobbs-Merrill Company. 1926. $5.00.

WE are just at the beginning of the avalanche of first hand biographies and autobiographies which must inevitably follow an event of such magnitude as the World War. These publications constitute the first stage of writing the true history of that conflict; by the reading and proper evaluation of these works and official war histories the historian of the future will painfully evolve a real history of the World War. The annoying thing to the present day general reader is that many of these books are largely apoligies for the part taken by the great leaders in a war where the mediocrities far outnumbered the brilliant strokes.

This biography of Lord Allenby, by one of his staff officers, is refreshing in that it in no sense tries to explain or justify the conduct of Lord Allenby during the World War. This does not appear to be due to any lack of admiration on the part of the author for his former chief but simply due to the fact that there is little or nothing to apologize for. Allenby was one of the outstandingly successful leaders on the side of the Allies and his campaigns are among the main glories in the costly victory of the Allies. Although he was fortunate enough to conduct his Palestine campaign far from the apron strings of the politicians his conduct of the campaign must for long stand as the classic example of how to conduct a modern large scale encounter with an enemy equally as skillful and well equipped.

Field Marshal Allenby is a cavalryman. The story of his life bears a striking resemblance to that of some of our own military leaders in the World War. The long, hard and discouraging early years spent in uncomfortable, uncivilized and far-away places fighting to consolidate the colonial gains of the homeland, working with inadequate means and no thanks or recognition from the hordes at home who after the pacification became rich on the commerce with the new colony. Many a colonel or general who reads the first part of this book will think to himself, "Just like the Philippines".

There is one criticism which must be made against this book which can be corrected in subsequent editions and that is that there are no maps of the operations in northern France in which Lord Allenby took such a brilliant part. The author gives an entertaining and remarkably clear account of the rather involved battles in Flanders where millions died for small territorial gains, but it is hard to follow without a map, or a detailed knowledge of the geography of that part of France.

The real meat of the book is, of course, in the account of the campaign in Palestine. The careful preparation for the campaign, the long lines of communication, the difficulty of transport, the lack of water, the flank attacks and the free, full and proper employment of cavalry all contribute to make the study of Allenby's complete defeat of the German-led Turks the ideal example of the proper conduct of large operations. There is a map of the Palestine sector.

The career of this great soldier will always stand out because of his brilliant use of cavalry. This book shows that there still exists in modern warfare an important function for this arm except in the very special case of stabilized trench warfare as conducted on the Western front. However, there are indications in the book that although the function of cavalry has not changed some of its tactics and weapons have, at least under some conditions. The following quotation (page 80) shows to what extent the Germans went in modernizing their cavalry: "The Cavalry Corps under von Marwitz, diverted by a tedious detour, was built up by the army cavalry of the entire right wing, three full divisions with horse artillery, armored cars, and formidable machine-gun units in lorries, and the pick of the Jaeger from the three armies." This was on the Western Front. Speaking of the operations in Palestine, where cavalry clinched the victory, we read (page 202): "The Ford car was of inestimable value; there were no hillocks of shifting sand through which it would not plough, no boulders over which it would not pick its way, no precipice which it would not negotiate."

The final part of the book which deals with Allenby's administration of Egypt during the height of the Nationalist movement will be of interest to all Americans concerned over the future of the Philippines; it shows that polyglot backward peoples cannot rule themselves so as to form a stable government in the sense accepted by Western civilization.

This book is written in a clear and interesting style so that it will appeal both to the general reader and to the student of history and world affairs.

JOHN. K. CHRISTMAS.

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FRED'K A. MUSCHENHEIM

War Weather Vignettes. By Alexander McAdie. New York: The Macmillan Co. 1925. $1.50.

PROFESSOR McADIE has chosen a title, the reading of which causes the war veteran's memory to pass in review countless situations where the weather was the deciding factor in battle results. Of these numerous incidents, five concerning the World War have been chosen as subjects for essays, which appeared originally in the Harvard Graduates Magazine and are here collected for the perusal of an enlarged group of readers. "War and Water" tells of the result of the loss of a water supply camel train during the Syrian campaign. High tribute is paid to the troops, suffering from thirst, who waited for hours, while the wounded and disabled were given water, before they quenched their thirst. "Where Weather Won" describes how weather caused the tide of battle during the Battle of Jutland in 1916 to turn and allow the German fleet to retreat before it could be sunk by the Grand Fleet.

"The Wind Gods at Gallipoli" describes how disastrous was the weather on the outcome of the Gallipoli Campaign, how in February, 1915, unfavorable winds drove the British fleet to sea before it could surprise and force the Straits, and how later in November a three-day blizzard was so disastrous that all hope of ultimate success was despaired of, with the result that the campaign was finally abandoned. "John Gilpin Aloft" is concerned with the useless trip of 4,000 miles of the L-57, a Zeppelin sent by the Kaiser with supplies for the relief of Von Lettow-Vorbeck in German East Africa and which was recalled before accomplishing its mission because of a fake message. The delay thus caused aided by tropical downpours had its telling effect on the results in this theater of operations. "Fate and Forecast" describes how an incorrect weather forecast caused the course of the *Hampshire* carrying Lord Kitchener on a diplomatic mission to Archangel in June, 1916, to be laid through a western channel out of Scapa Flow so as to steam in the lee of the Orkneys, how the winds shifted and she actually sailed on the weather side of the Orkneys with the result that her torpedo boat convoy turned back and the *Hampshire*, Kitchener of Khartum, and practically all on board were lost when the ship hit a mine.

ARTHUR W. FORD.

Heat Transfer and Evaporation. By W. L. Badger. New York: Chemical Catalog Company. $5.00.

THIS book presents a clear and concise treatment of the subject of heat transfer and evaporation from the theoretical and practical standpoints. The first part of the work treats of heat transfer while the latter part is devoted to the application of the principles discussed to the design and use of evaporators.

The author's own experience and research on this subject are given in two chapters and the information contained therein fully illustrates his qualifications to handle a subject of this nature. The book is replete with illustrations and descriptions of the different types of evaporators in use.

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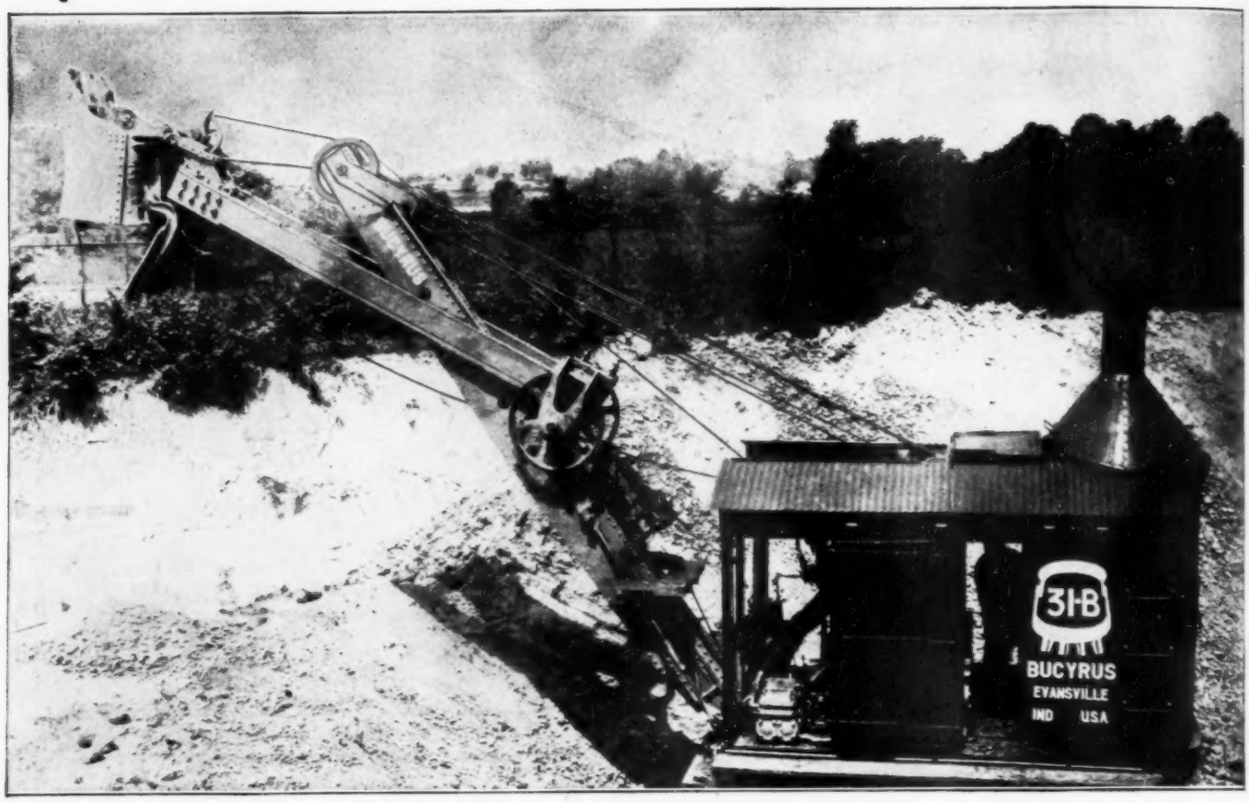

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